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Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

American Fine Arts Society Building, New York, where priceless art exhibits of the Architectural League were destroyed. (See page 308.)

The Quarterly

Vol. 13 April, 1920 No. 4

CHICAGO.

Smoke and tawny air;
Bricks blurred with black,
Softened with dusk,
Edges clouded with smoke—
Great human thing, beautiful with ugliness,
Gripping our hearts because you are big and clumsy and kind!

Helen Hoyt.

Twenty-fourth Annual Meeting. This is Chicago year for the annual meeting and nobody seems at all sorry about it. Helen Hoyt, who wrote the above lines, is a Chicago poet but has, nevertheless, very accurately expressed a common Eastern feeling toward the big city by the lake. We come away from it, perhaps, with our faces streaked with soot, but with a very real notion of having done something worth while. Chicago is a city of accomplishment and some of the Association's most forceful strides have been made under the spur of her inspiration.

We shall have this year, however, a note of successful endeavor from farther west. Jay W. Stevens of San Francisco, of whom we had a glimpse last year at Ottawa, has promised to tell us of his fire prevention work on the Pacific Coast and of the results already accruing from it. He will bring with him the new motion picture worked out by the Ince studios with the co-operation of our fire chief members west of the Rockies.

We shall pay our usual afternoon visit to Underwriters Laboratories, and Chicago Chapter is planning a luncheon.

The official program to be mailed to members shortly and the announcements in the *News Letter* will indicate the budget of committee reports to be presented, which is of no mean dimensions. This is the year for amendments to the *Automatic Sprinkler* regulations and a lively discussion is foreshadowed. The *Committee on Signalling Systems* has been digging its toes in since the Ottawa meeting and looks for plain sailing. A sub-committee of the *Committee on Automatic Sprinklers* will have something to offer on *Gate Valve Control.* The *Committee on Field Practice* will present regulations for placing "first aid" devices. The *Committee on Inflammable Liquids* will expect careful consideration of its *Fuel Oil Regulations,* and the *Committee on Hazardous Chemicals and Explosives* is to keep its promise to bring in proposed regulations governing *pyroxylin plastics.* The *Committee on Safety to Life* never fails of an interesting report, and the *Committee on Docks, Piers and Wharves* is to

make its initial bow this year. The *Committee on Gases* is to represent its *gas piping* regulations and has new matter in the forms of regulations governing *refrigerating plants,* and regulations covering the installation and operation of plants producing acetylene for *compressed gas cylinders.* The *Committee on Building Construction* will add another section to its work already accomplished; the *Committee on Fire Pumps* will present a report; also the *Committees on Manufacturing Risks and Special Hazards, Standardization of Pipe and Pipe Fittings,* and *Small Hose Couplings.* There is obviously matter enough in the above budget to keep us all out of mischief.

* * * * *

British Fire Losses in 1919 Fire losses in Great Britain during December last, as compiled by the London "Times," reached a total of £440,000, as compared with £384,000 for the same month in 1918. This brings the total fire waste for the year 1919 up to the unusually large figure of £10,217,550, or practically double the record of the previous year, which was £5,174,200. The record of the year by months, together with a comparison for 1918, is given below, only fires of £1,000 or more being included in the estimate:

	1919.	1918.
January	£1,146,700	£412,500
February	485,400	297,708
March	421,100	338,400
April	176,950	344,100
May	506,700	312,000
June	4,576,200	467,500
July	576,800	498,000
August	366,700	404,000
September	445,000	703,000
October	498,000	363,000
November	378,000	650,000
December	440,000	384,000
Total 12 months	£10,217,550	£5,174,200

* * * * *

A New Automatic Fire Alarm! Strange manifestations of super-intelligence occasionally come out of Philadelphia, but two fire alarms from garages recently reported by William McDevitt (Member N. F. P. A.) indicate a sensitiveness of automobiles to pain inflicted by burns unusual even in the non-resistant atmosphere of the Quaker City.

In Arch street, in the rear of a number of stores is a garage, 75 feet in length, with brick walls and a wooden roof. It houses 60 automobiles.

On January 29th at 1.40 A. M. this garage was closed, as any respectable garage in Philadelphia would be, at that hour. There was a colored man employed as watchman. He reported that while "working around" he heard a horn blow and looking over, saw a car on fire. He ran out and turned in an alarm. The department responded and found three cars on fire, to which by quick and intelligent work the damage was confined.

As the watchman admitted he did not observe any smoke or fire until the "horn blowed," it is assumed he was asleep and was awakened by the horn. The fire originated, possibly, from a bunch of oily waste in the

car, and, burning off the insulation on the wires leading to the horn, caused a short circuit which operated the alarm.

This is the second case of the sort in which a horn on a burning car announced the presence of a fire in a closed garage.

* * * * *

Brick Manufacturers Make Progress. For a new organization, meeting in only its second annual convention, our members of the Common Brick Manufacturers' Association of America made real progress at Columbus in February. It threw the weight of its organization and influence in favor of a standard size for brick. Architects, builders and engineers have long been confronted by confusion in this matter, and to be able to count and figure on a standard dimension for this material, the same for common as for face brick, will be a matter for rejoicing. The standard size is to be 2¼ by 3¾ by 8 inches. This standard has now been adopted by the American Face Brick Association, the National Brick Manufacturers' Association, and the Common Brick Manufacturers' Association, and the Committee C-3 of the American Society for Testing Materials is voting to change the tentative size adopted by that society to conform.

Under the inspiration of the eloquence of D. Knickerbacker Boyd of Philadelphia, former secretary of the American Institute of Architects and a member of the Executive Committee, N. F. P. A., who is consulting architect for the Common Brick Manufacturers' Association, that body also passed at its convention a very forceful and interesting resolution calling for scientific treatment of the whole subject of building materials and their use with a view to conservation of buildings from fire attack.

* * * * *

The Sky-Scraper Menaces London. Sir Martin Conway, scientist and mountain climber, has stirred up an animated discussion in England by his proposal to abolish restrictions on the height of buildings in London and erect skyscrapers. His plan, however, is not to imitate New York's lawless architecture but to provide for a symmetrical distribution of high buildings with open parks between. If he had his way, he told the London society, he would knock down London acres at a time. He would lay the east end flat and set it up on end. He would erect gigantic communal buildings, 30 or 40 stories high, housing thousands of people. The response which his daring project received shows that the high buildings of New York have made an impression on the multitude of British visitors in America. But the extension of public control required to put the high buildings at the right places and to convert adjacent land into parks would be revolutionary anywhere and specially so in a city which has developed like London with the minimum of governmental interference.

Architectural League Fire.

Extract from Report by New York Board of Fire Underwriters.
(Member N. F. P. A.)

The building fraternity of the nation suffered a very serious loss when the exhibits of the Architectural League were destroyed in a fire occurring in the American Fine Arts Society building, West 57th St., New York City, January 30, 1920, at 10 A. M. These exhibits, which were being placed for international display, were destroyed together with the building in which they were located at a loss of three quarters of a million dollars. Architectural drawings and interior decorations of great value and indicative of the last word in modern artistic development had been housed in an old art gallery of highly inflammable appointments and furnishings.

Construction.

The building extended from West 57th Street to West 58th Street and was divided into four portions known as Main Building, which fronted on West 57th Street; Vanderbilt Gallery, which fronted on West 58th Street; South Gallery located on north of Main Building, and Center Gallery located between the South and Vanderbilt Galleries. The Main Building was four stories and basement in height, the remaining portions were one story and basement in height. In the one story portions, in which practically all the damage occurred, the finish was part plastered on wood furring, also part burlap on wood sheathing on wood nailing strips. Partitions were part 4 inch hollow tile and part wood; also temporary partitions constructed of beaver board on wood studding. The floors were 7/8 inch wood, on wood sleepers, on hollow tile flat arches, on steel I beams, girders and cast iron columns. The roofs were composition, slag covered, on arches and supports similar to floors in the main building, and on steel frames and trusses on one story portions. The webs of the beams and girders were protected by the floor arch construction and the lower flanges were protected by 1-inch skew back tile; the cast iron columns and the steel roof trusses in the one story portions were unprotected. The main building was separated from the one story portions by a heavy brick wall with unprotected openings on the basement and one opening on first floor protected by sub-standard metal covered panel doors with wired glass transom above. The Center Gallery was separated from the Vanderbilt Gallery by a 20-inch brick wall, with a large unprotected opening, and from the South Gallery by a 4-inch tile partition with a large unprotected opening.

Story of the Fire.

The origin of this fire is not known. The Architectural League were preparing for an elaborate exhibition and workmen were busy installing electric wires, painting and erecting partitions, while members of the

Ruins of the Center Gallery.

(See frontispiece for front view of building.)

league were arranging exhibits. The fire started in a small beaver board enclosed room among inflammable draperies and decorations on the south side of the Center Gallery on the first floor. Workmen who were in this gallery stated that no one was in this small room when the fire started. There was a switch board on the side tile wall near the floor in this room and electricians had been installing additional wires from this board. It is claimed that the electric current had not been turned on any of the new lines.

A member of the public fire department, located directly across West 58th Street from the American Fine Arts Society building, noticed smoke coming through one of the roof ventilators over the Center Gallery. This company at once responded and one of the firemen went to the public fire alarm box located at West 58th Street and Broadway, and turned in an alarm. Someone operated the alarm box located at West 57th Street and 7th Avenue at 10.00 A. M. just before the box at Broadway and West 58th Street was operated. Second and third alarms were sent in at 10.05 and 10.25 A. M. respectively.

The fire spread very rapidly to other inflammable decorations and along the burlap and light wood finish, glued or nailed to wood strips on the side walls with space between the burlap and wood finish and the walls. The fire also spread to the South and Vanderbilt Galleries through the unprotected openings in the dividing walls.

As soon as the men working in the Center Gallery noticed the fire they tried to extinguish it by pulling down the inflammable decorations

and draperies and also by using 2½ gallon extinguishers. The fire gained headway very rapidly and these men had to run for their lives. A total of eight engine and four hook and ladder companies of the public fire department responded to the fire alarms and the fire was fought by the firemen from each point of the compass. The engine company which is located directly across West 58th Street from the scene of the fire ran lines into the buildings on the first floor, but the fire gained headway with such rapidity due to the inflammable decorations that they were compelled to retire from the building. Just as soon as they got out, the roof of the Vanderbilt Gallery fell. The fire was fought from the tops of adjoining buildings on West 58th Street and by pulling lines through the first floor of the main building on West 57th Street.

The first floors of the Center and Vanderbilt Galleries were gutted by fire or buried under the steel trussed roof of the Vanderbilt Gallery which quickly fell in. The structures of the South and Center Galleries were damaged a little by fire but most of the exhibits in the South Gallery were removed to the main building. The contents in the basement under the one story portions were damaged by water. With the exception of a little water damage to the contents in the basement of the main building, this section was not injured. There was no loss of life but several firemen, and some of the workmen who fought the fire, were badly burned or injured by falling glass.

Conclusions.

The principal undesirable features from the fire protection viewpoint brought out by this fire are:

Extensive use of inflammable draperies and tapestries for decorations.

Burlap and wood sheathing on wood nailing strips with air spaces between the finish and the walls which form channels facilitating the rapid spread of the fire and also serving to make it inaccessible.

Unprotected steel roof trusses in one story sections.

Lack of fire door protection at communications through fire walls.

Lack of automatic sprinkler protection in rooms containing considerable quantities of inflammable material and valuable contents.

"Industrial Democracy" and Fire Prevention.

By Convers Goddard.

(Member N. F. P. A.)

An interesting instance of efforts in the direction of improved fire protection originated by the workmen themselves was recently brought to the writer's attention while attending a meeting of the "Senate" of a large manufacturing plant.

"Industrial Democracy" provides for a system of plant management which affords representation by all employees. It is based upon the form of government of the United States, and affairs are administered by a Cabinet consisting of executive officers, a Senate consisting of heads of departments and foremen, and a House of Representatives consisting of representatives elected by the workmen and office force. Many of the affairs are administered by the medium of committees, and one of the permanent committees is the joint Safety Committee of the Senate and House. At the Senate meeting referred to, the following report was adopted:

[*Excerpt from the Minutes of the Meeting of the Senate, Curtis Bros. & Company, Clinton, Ia.*]

October 24, 1919.

"The Safety Committee, in their report, suggested that the Senate be asked to consider the advisability of having a City Fire Department alarm box situated on 12th Avenue so that in case of fire the alarm could be given instantly.

Senator Ohrt suggested that it would be a good idea to have all employees fully posted in regard to the location and use of the various types of fire-fighting apparatus available.

Senator Perrin suggested that in addition to this a fire drill should be practiced so that in the time of trial the men would know just what to do.

Senator MacNicoll suggested that the management request the city fire chief and his assistants to come down to one of the mass meetings of the employees, demonstrating at that time the proper use of the fire-fighting apparatus we now have and at the same time familiarize themselves with the locations of our patent extinguishers, hose reels, fire barrels, etc., for it was felt that this knowledge would be a big help to the department in case of a fire."

The fact that these suggestions originated with the workmen themselves makes it probable that instruction in the use of fire-fighting appliances will be taken more seriously than would be the case had the suggestions come from the management or an inspector, and the same beneficial result of "Industrial Democracy" is observed in connection with prevention of industrial accidents, the experience indicating that, given an opportunity to voice their sentiments, the workmen will show initiative in the direction of the preservation of life and property.

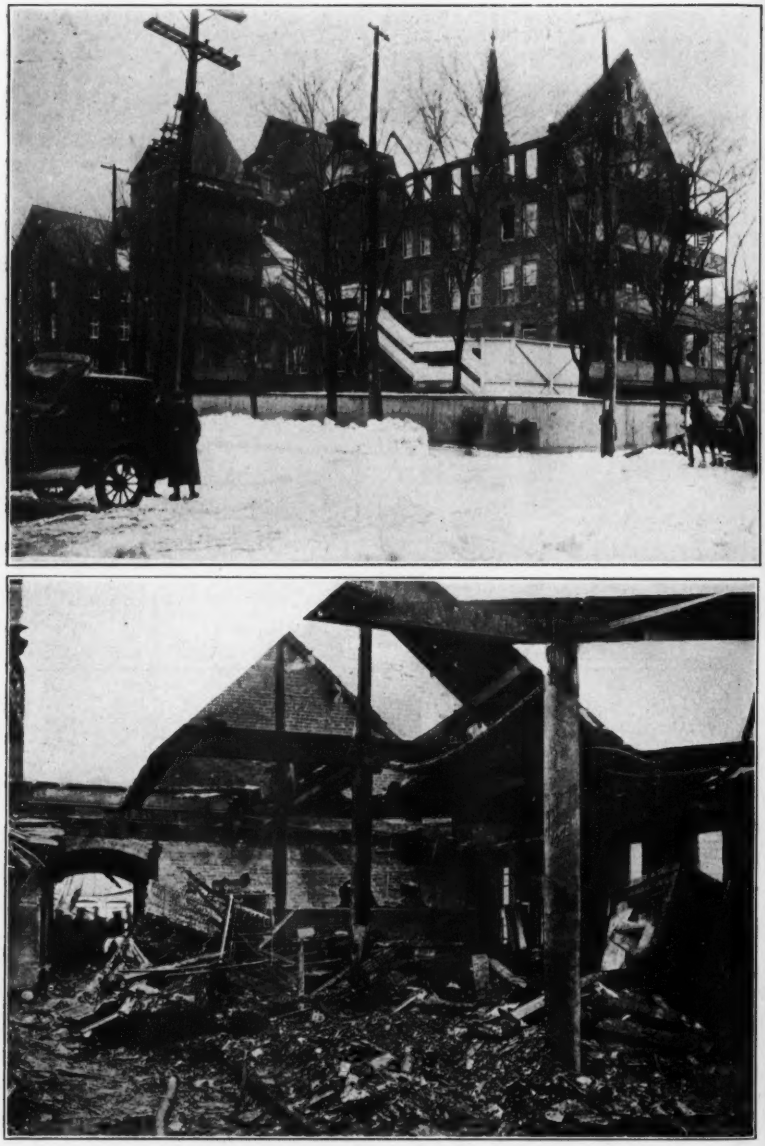
Courtesy Eastman Kodak Company.

BAD HOUSEKEEPING AND CARELESSNESS.

Unguarded radiators.
Unprotected electric light globe over film.
Wire wrapped around steam pipe.
Film scrap on floor.
Lengths of film on floor.
Willow waste basket used.
Film on fire extinguisher.
Too much film on each table.
FILM NOT KEPT IN CANS.
SMOKING.
Waste paper and newspapers on floor.
Posters in same room with film.
Lack of order and cleanliness.

GOOD CONDITIONS, HANDLING JUST AS MUCH FILM.

Automatic sprinkler system.
Radiator guarded properly.
Electric lights guarded properly.
No wires wrapped on pipes.
Metal waste cans.
No scraps or loose film lengths on floor.
Small quantity of film on each table.
All film in cans except that being worked on.
Metal furniture used.
1¼" Hand hose and fire extinguisher in proper place ready to use.
Order and cleanliness.



West wing of Grey Nunnery, Montreal, after the fire of Feb. 14, 1918. In spite of unusual heroism on the part of nuns and convalescent soldiers, one hundred children perished. Lower picture shows room from which firemen removed forty little bodies.

Fire Protection for Hospitals, Asylums, and Similar Institutions.

By H. W. Forster.
(Member N. F. P. A.)

Over a million sick, crippled, aged, blind, insane, orphaned, and otherwise unfortunate or defective persons are ordinarily found in some ten thousand institutions in our country. Hundreds of millions of dollars are required for their care each year. Intelligent and devoted service on the part of managements and staffs makes the large majority of our institutions not only effective agencies of amelioration and reconstruction, but constitutes the greatest example of Christian service that can be found in our modern civilization.

But there is a blot on this service-to-the-unfortunate-man escutcheon; namely, the frequency of fire outbreak and the life and property loss that follow. A hospital burns every day; half that many asylums or other institutions are damaged or destroyed each week. Of every sixteen institutions in the country, one suffers a serious fire each year and several times as many fires occur without assuming sufficient size to get into the public print, or to become matters of insurance adjustment.

And the lives of new-born babies and their mothers, of orphans and grandsires, of the paralyzed and the violently insane, of the crippled and the blind, are snuffed out singly, in small groups, and occasionally by the score.

Sisters of mercy facing certain death to rescue their orphan charges, nurses bravely risking their lives to remove helpless patients, asylum attendants fighting the fire-crazed insane to tear them away from places of danger; these acts prove the heroism of which men and women are capable. The necessity for these acts lies largely in ignorance and carelessness and, occasionally, criminal disregard of the fundamentals of fire prevention and fire protection. Competent men can detect the possibility of fire with almost absolute certainty; the means of prevention and protection are available to anyone who desires information; and the cost of securing a large degree of safety is not prohibitive. Therefore there is no excuse for the majority of the dangerous conditions which exist today in our institutional buildings.

If fire protection is warranted in our factories, warehouses, and stores, where daytime use and physically fit occupants are the rule, how much more necessary is fire protection in institutions which are used twenty-four hours of each day in the year and filled largely with the helpless?

NOTE: The author desires to acknowledge material assistance in the preparation of this article rendered by Mr. C. W. Burnham, member of the National Fire Protection Association's Committee on Public Information.

It is a cause for rejoicing that there are today many institutions which in whole or in part from a fire safety standpoint approach the ideal. They prove the feasibility of the thing the student of institutional fire conditions knows is needed. But the number of truly safe institutions is small and in the large majority of older institutions the conditions frequently are appalling.

Fire originating in a linen closet burned 38 persons to death; 12 feeble minded persons were killed in a building known to be a death trap; over 50 children perished in a fire that broke out in the top story of a six story tinder box; thus the record has been and thus the record will continue to be unless the seriousness of the problem is generally recognized and corrective measures are taken. Defective chimneys, poorly installed stoves and furnaces, defective electrical equipment, careless handling of inflammable liquids, spontaneous combustion in accumulations of rubbish, smoking, and carelessness with matches are among the fire dangers that jeopardize life in institutional buildings and are responsible for much of the fire outbreak.

The function of this article is to drive home the seriousness of the existing conditions, to point out some of the reasons for these conditions, and to set forth the essential facts that the management of an institution needs to know to enable adequate fire prevention measures to be taken and suitable protection to be provided.

Responsibility of the Management.

The responsibility for the existing conditions is squarely up to the management of our institutions. Up-keep and inexpensive fire prevention measures are the direct responsibilities of the local management. The local management must also urge upon the boards of directors or governors of private institutions, and upon the state or national boards or bodies which have final authority in the case of public institutions, those major and more expensive fire protection or structural improvements essential to secure maximum safety to life.

The cause of the fire in the linen closet referred to previously could and should have been detected and removed; the institution for feeble-minded where life loss occurred had been warned regarding inadequate egress conditions; even rudimentary knowledge of fire protection would have shown the acute jeopardy under which hundreds of children were housed in the six-story, cage-like, thoroughly combustible asylum. Had the fire not occurred in the top story, the life loss would have been far greater. Ignorance is no excuse under the law; ignorance is no excuse where lives are entrusted to an institutional management. It must not be forgotten that the inmates are seldom in an institution of their own choice.

Politics have always played an important part in the management of such institutions, and investigation has revealed former farmers, policemen, contractors, and other persons wholly unqualified in complete control of medical and semi-medical institutions. Boards of directors are frequently controlled by local politics, institutional positions are filled to

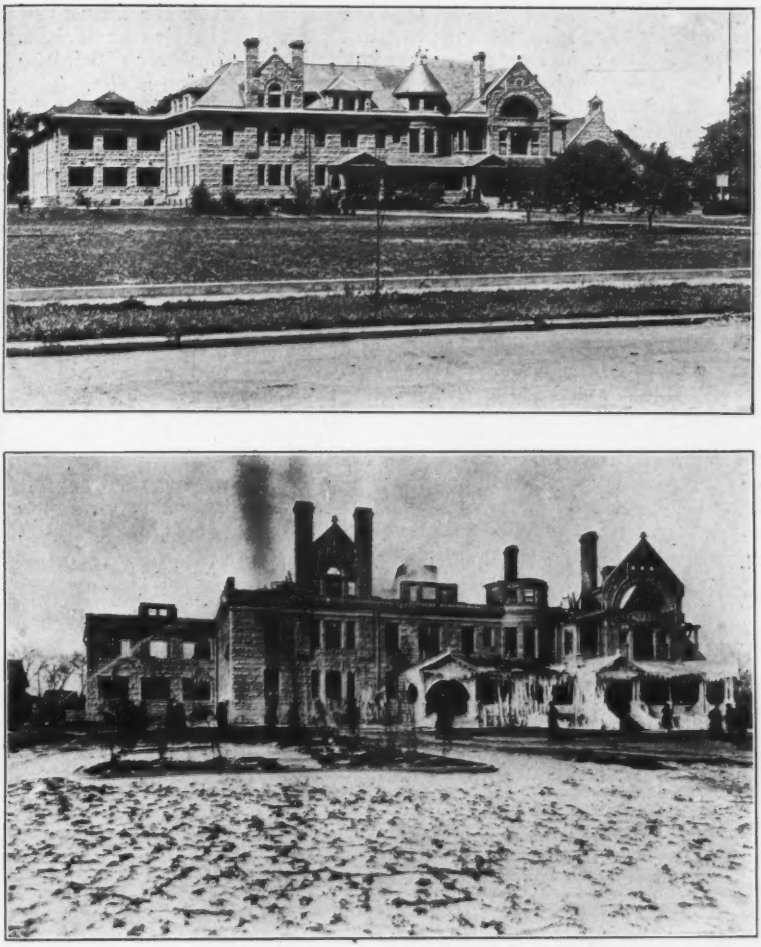


Fig. 1. The Masonic Home in Wichita, Kansas, before and after the fire of December 22, 1917. This imposing structure, which looked safe to a layman, was destroyed with a loss of five lives, because of a wooden interior and no adequate fire protection.

pay political debts, and political appointees often handle the finances of the institution in such manner as to divert a portion to their own pockets. There was one superintendent of an institution housing over 600 insane who died from alcoholism, his successor being a morphine addict. This position paid a salary of $4000 per year, and seemed so desirable that the next superintendent, another political appointee, lobbied for an entire year at the state capitol to secure it. The outlook for fire prevention under such conditions is not hopeful.

In the majority of the institutions some steps have been taken to provide protection against fire. These sometimes are so meagre and misdirected as to be practically worthless, as was the case in an institution for blind children, where a liberal supply of dry powder extinguishers had been provided, but where no provision was made for fire alarms or exits, even on the upper floors where the children slept.

High Points in a Twelve Year Record.

From the available records for the past dozen years have been selected the following fires as typical of several thousands that have taken place in that time. Every part of the country and practically every form of institution is represented, and the data are as accurate as generally inadequate American fire records make possible. About 250 deaths are covered by the list, and this is only a portion of the life loss in that period.

1. House of Providence, near Syracuse, N. Y., Dec. 8, 1907.
   Property loss, $135,000.
2. St. Ann's Orphan Home, Terre Haute, Ind., Jan. 2, 1908.
   Property loss, $30,000.
3. French Hospital, San Francisco, Cal., Jan. 6, 1908.
   Property loss, $50,000.
4. Mercy Hospital, Big Rapids, Mich., April 21, 1908.
   Property loss, $75,000.
5. German Old People's Hospital, Dimond, California, July 3, 1908.
   Property loss, $60,000.
6. State Custodial Asylum, Ward Bldg., C., Rome, N. Y., November 1, 1908.
   Property loss, $125,000 none of which was covered by insurance.
7. Whitwell Hospital, Tucson, Arizona, Dec. 29, 1908.
   Property loss, $50,000.
8. Mahoning County Infirmary, Canfield, Ohio, Jan. 21, 1909.
   3 *persons killed and* 14 *injured.*
   Property loss, $30,000.
9. Biggs Sanitarium, Greensboro, N. C., March 12, 1909.
   1 *person killed.*
   Property worth $22,000 destroyed.
10. New York Infants' Asylum, New York City, May 24, 1909.
    Property loss, $25,000.
11. St. Malachy's Home for Children, Far Rockaway Beach, N. Y., Aug. 30, 1909.
    7 *children killed.*
12. Virginia Synod Presbyterian Orphanage, Lynchburg, Va., Oct. 26, 1909.
    5 *children burned to death.*
13. Masonic Home for Aged, Grand Rapids, Mich., Feb. 26, 1910.
    Property loss, $53,000.
14. Hempstead Poor House, Hempstead, L. I., N. Y., March 9, 1910.
    1 *old man burned to death and* 5 *other inmates seriously injured.*
15. Page County Farm, Clarinda, Iowa, March 23, 1911.
    1 *aged inmate burned to death.*
16. Hamilton Asylum for Insane, Hamilton, Ont., Aug. 1, 1911.
    8 *persons burned to death.*

Fig. 2. All that is left of a maternity hospital in Oklahoma. Such possibilities do not encourage patronage of hospitals.

17. Colored Orphans' Home, Lexington, Ky., Feb. 27, 1912.
    3 *small children perished.*
18. James Sanitorium, Raleigh Springs, Tenn., May 14, 1912.
    1 *man burned to death.*
19. Martin's Sanitorium, Louisville, Ky., October 30, 1912.
    2 *patients killed.*
20. St. John's Orphan Asylum, San Antonio, Tex., October 30, 1912.
    6 *lives lost.*
21. Brunswick Home for the Feeble Minded, Amityville, L. I., N. Y., Nov. 24, 1912.
    1 *person killed.*
22. Fairmount Children's Home, Alliance, Ohio, November 8, 1914.
    A matron used an oil lamp at 1 A. M. because the electric generator was regularly stopped at 9 P. M. and no storage batteries were provided. Lamp exploded. *The matron was killed,* and 25 boys and several adults escaped with difficulty.
23. Delaware County Infirmary, Muncie, Ind., March 23, 1915.
    Many of the inmates were feeble minded. Fire escapes and fire alarms had been ordered by the state inspector, but not installed. 12 *inmates were killed.*
24. St. Francis' Girls Directory, San Francisco, Cal., Sept. 4, 1915.
    5 *lives lost.*
25. Harney County Hospital, Burns, Oregon, Oct. 29, 1915.
    Building was entirely destroyed. *One person was burned to death* and others were rescued with difficulty thru smoke and flames.

26. Schoffner Hospital, Nashville, Tenn., April 5, 1916.
A nurse lighted a match while drawing alcohol in small closet. *The nurse and several patients were killed.*

27. Roman Catholic Hospital, Farnham, Quebec, Canada, Oct. 26, 1916.
Fire occurred on October 25 from defective chimney and was extinguished. Fire broke out on the following day, possibly from the same cause, *and resulted in the death of 27 persons and the injury of many others. Many little children were horribly injured by jumping from upper stories.* The fire spread very rapidly and there was a terrible panic as patients and attendants fought for exits.

28. Kansas Masonic Home, Wichita, Kansas, December 22, 1916.
Combustible interior of a beautiful stone building completely burned out. *Five children were killed.* The inmates were rushed out into ice and snow and saved from freezing by clothing and bedding taken from nearby homes. (See Figure 1.)

29. Boone County Poor House, Boone, Iowa, March 8, 1917.
Fire destroyed building. *One aged woman and three men were burned to death.* 56 others narrowly escaped in their night clothes.

30. Hotel Dieu Hospital, St. Hyacinthe, Quebec, Canada, November 28, 1917.
1000 inmates removed. *One life lost.* Building completely destroyed.

31. Connecticut State Hospital, Middletown, Conn., Januarv 10, 1918.
Fire started in attic on a winter night. *Three inmates were killed and there were several injured.*

32. Catholic General Hospital, Ottawa, Canada, January 10, 1918.
Five children and one woman killed. Property loss, $100,000.

33. Grey Nunnery, Montreal, Canada, Feb. 14, 1918.
Nurses, soldiers, and firemen made heroic efforts to save the aged and children. *More than 50 babies were burned to death.*

34. State Hospital for the Insane, Norman, Okla., April 13, 1918.
Women nurses risked their lives in heroic efforts to carry out crippled and paralytic patients from burning building, while patients fought their rescuers. 38 *men and boys were burned to death,* most of them in bed where they were overcome by the smoke. Property loss, $40,000.

35. Hospital for the Insane, Columbia, S. C., May 29, 1918.
Fire was probably caused by defective electric wiring. One ward building was destroyed, 10 *patients were killed and many were injured.*

36. Erie County Home and Hospital, Buffalo, N. Y., June 15, 1918.
Fire started from the explosion of a steam cylinder head. Eight buildings were completely destroyed. 350 patients, including new born babies and mothers from the maternity ward, were rescued and placed on the lawn. Because of high elevation, water pressure was not sufficient to fight fire. Property loss, $200,000.

37. Kent County Juvenile Home, Grand Rapids, Michigan, July 23, 1918.
Fire was caused by defective electric wiring in the laundry. Children were locked in rooms on the third floor and only one fire escape was provided. 5 *children were burned to death, and 3 were injured.* Property loss, $25,000.

38. Worcester State Hospital, Worcester, Mass., February 6, 1919.
Fire started from electric wiring in attic when an insane patient pulled an electric fixture from the wall. 800 insane patients were removed. Loss, $20,000.

39. St. Mary's Hospital, Jefferson City, Mo., Feb. 20, 1919.
Fire occurred in a four-story stone and wood joisted building. Loss, $150,000.

40. Henry Boyle Catholic Home for the Aged, Fond du Lac, Wis., Feb. 28, 1919.
3 *persons killed and* 5 *injured.* Property loss, $40,000.

41. Hospital for Insane, Richmond, Ind., March 5, 1919.
1 *person killed.* Property loss, $25,000.

42. German Roman Catholic Orphanage, Buffalo, N. Y., March 7, 1919.
Property loss, $50,000.

43. Methodist Orphanage Home, Macon, Ga., March 10, 1919.
Property loss, $15,000.

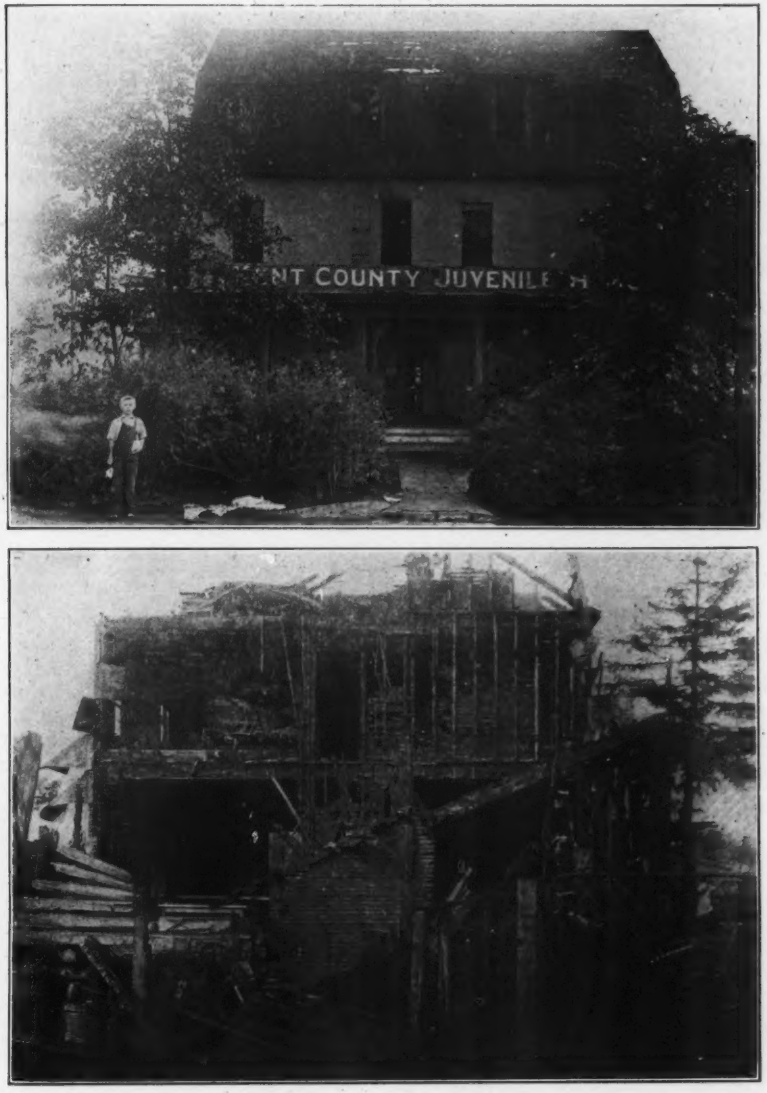


Fig. 3. The Juvenile Detention Home, Walker Township, Grand Rapids, Michigan, destroyed July 22, 1918, with five children burned to death. Lower picture shows practically all the rear walls of this wooden trap burned, leaving only embers.

44. Benton County Infirmary, Oxford, Ind., May 9, 1919.
Property loss, $45,000.
45. Marlin Hospital, Marlin, Texas, July 10, 1919.
Gas explosion in sterilizing rooms. *Seriously injured the woman superintendent.*
46. Beauport Asylum, Quebec, Canada, July 19, 1919.
A 150 ft. chimney dropped upon the building when struck by lightning. *One person was killed.*
47. Maternity Hospital, Muskogee, Okla., July 19, 1919.
Property loss, $100,000. (See Figure 2.)
48. State Home for Girls, Trenton, N. J., July 23, 1919.
Girls fired oil soaked rags in attic, planning to escape during the excitement of fire. Property loss, $100,000.
49. Shaughnessy Military Convalescence Hospital, Vancouver, B. C., Sept. 20, 1919.
Fire destroyed one wing of hospital. All patients were carried to safety by rescue parties.
50. Mercy Hospital, Big Rapids, Mich., December 1, 1919.
Building completely destroyed. *Five killed and three injured.* Property loss, $100,000.
51. Connecticut State Hospital, Middletown, Conn., December 23, 1919.
One frame building entirely destroyed. *Several insane patients perished.* Property loss, $25,000. The second instance of life loss from fire at this institution within two years.
52. Home for Aged Women, Lynn, Mass., February 23, 1920.
Fire started in basement and spread rapidly through hollow partitions. *Four old ladies from 70 to 92 years of age were killed.*

Money for Fire Protection.

That institutions of all kinds are generally in need of money for operating and expansion purposes is a well known fact, and one which has militated against improvement in fire conditions. Also, there is a feeling on the part of the layman that fires are acts of GOD and that during the regime of the given management no fire horror is likely to throw discredit upon it. The Act of God theory is untenable. Even lightning damage can be prevented by a modern lightning rod installation. The fact that a hospital burns every day, and that a carelessly discarded match or cigarette, a misused electric iron, or a red hot stove pipe may bring death at any time should definitely answer the man who thinks that his institution is immune from danger.

If the management really wants increased fire safety it can secure the necessary funds. A fire horror always stimulates improvement, and there are numerous cases on record of states, cities, societies, and individuals providing money for protection in advance of any ocular demonstration of the fallacy of "the head-in-the-sand" policy. As evidence of this it may be noted that about one hundred institutions throughout the country have installed automatic sprinkler protection, in whole or in part, and that a few have made notable improvement by the installation of fire walls, better exits, and improved protection.

In 1917 the New York Commissioner of Charity had a survey made of 32 institutional buildings, and subsequently approximately $150,000 was spent for improvements. In 1914 and in 1915 the Wisconsin State Commissioner of Insurance had a survey made covering his principal

Fig. 4. The burning of the Harrisburg, Pa., orphanage asylum in 1916, is another case of an imposing combustible structure devoid of suitable fire protection. Fortunately it burned in the day time. Had this been a hospital, the beds in the foreground would have contained the helpless sick.

charity and penal institutions, which were subsequently much improved from a fire protection standpoint.

There are powerful forces which the conscientious management can bring to its aid in fighting the battle of fire protection — the greatest of which is public opinion. The truth told regarding the danger in hospitals and asylums has more than once gotten an instantaneous response. America certainly has wealth enough to give protection to her unfortunate.

Legal Responsibility.

While the possibility of injury to and death of inmates and attendants and the destruction of institutional buildings and equipment by fire is certainly consideration enough for providing every reasonable safeguard against fire danger, there is still another aspect of fire loss which must be carefully considered. Persons, or the relatives of persons injured or killed by fire in institutional buildings because of negligence on the part of the management in providing proper protection, are privileged by law to bring suit for damages against those responsible for the maintenance of the institution. Compensation can, of course, be claimed under the laws of the various states for employees injured or killed. In cases of heavy life loss, such claims may reach a very high figure. Nor does the liability of the institutions end here. Ordinances now in force — in Cin-

cinnati and Cleveland, Ohio; Portland, Oregon; Newark, N. J.; Billings, Montana; and Austin, Ranger, Cleburne, San Angelo, Wichita Falls, and Greenville, Texas; and which are being advocated in other cities throughout the country, fix the responsibility for the cost of extinguishing a fire upon the party whose negligence is responsible for the starting of it. Should fire start upon institutional property and, in spreading, cause injury to lives or property on adjoining premises, those responsible for the fire are liable under the common law for all damages caused. A law recently passed by the Canadian Parliament renders liable to two years' imprisonment any one who by negligence causes any fire which occasions loss of life or loss of property.

Types of Institutions Studied.

In the preparation of this article, consideration has been given to institutions of the following type:

HOSPITALS CLASSIFIED AS	INSTITUTIONS FOR
Acute	Aged
Chronic	Alcoholic
Contageous	Blind
Emergency	Cripples
General	Deaf and Dumb
Infirmaries	Drug Addicts
Maternity	Epileptics
Psychopathic	Feeble Minded
Tubercular	Indigent
	Insane
	Orphans

Essentials of the Problem.

The essentials of fire safety for institutional buildings and, in fact, for practically all other structures, are developed more in detail later in this article. In order, however, that a clear grasp may be had of certain fundamental and common sense principles, it is well to summarize in order that those interested may grasp the basic features of the whole problem.

Obviously the way to escape fire danger is to have no fires. That means fire prevention. Fire prevention has to do with removing the causes of fire, and covers the proper handling and storage of oils and other hazardous materials, the proper housekeeping measures, the disposal of waste of various kinds, the proper installation, inspection, and maintenance of lighting and heating equipment, and attention to other similar fire hazards.

Many of these fire prevention measures are mechanical, but a far greater number depend upon human inspection and performance. It is regrettably true that the human factor is not sufficiently dependable to

Fig. 5. 700 insane women were removed safely from this institution at Worcester, Mass., on February 6, 1919. Had the fire broken out in the basement of this building instead of in the top, the story would probably have been far different.

justify complete reliance upon fire prevention measures which presuppose continuous human fidelity and efficiency.

The next best thing to preventing a fire from starting is to see that any fire that starts is invariably extinguished while it is still small. The automatic sprinkler system is beyond question the most dependable device for accomplishing this, as is witnessed by a remarkable record of performance covering thirty-five years. This is summarized in the following statement unanimously passed by the National Fire Protection Association at its 1914 convention:

> "It is today an almost unquestioned fact that automatic sprinklers afford the highest degree of protection against fire in practically all cases where there is combustible construction or material, the rapid burning of which is liable to be a menace to the lives of occupants of the building."

Automatic sprinklers are entirely practical for institutional buildings in spite of the fear which some managements have of accidental opening of sprinkler heads at times other than during fire. It is a question of definite life safety from fire versus a remote possibility of a water spray from a single head being harmful to inmates.

Structural improvements and the use of fire-resistive building material in new buildings make possible a degree of safety in them which cannot be secured in existing structures except by the application of automatic sprinklers. It is the old building that generally is the most dangerous and for it the sprinkler is almost always the solution.

Fig. 6. The second floor in which most of the 18 dead were found after the Paterson, N. J., Salvation Army Rescue Mission fire of November 4, 1917.

Upon the carefulness and diligence which are exercised in fire prevention measures, and upon the provisions which are made for promptly extinguishing fire when fire prevention measures fail, depends to a considerable extent the problem of arranging for satisfactory egress. Because of the helplessness of many of the occupants, and the great difficulty of removing the sick, the question of egress is especially complicated, and while it needs and should receive proper treatment, unusual emphasis must be placed upon fire prevention and fire extinguishment.

Closely associated with adequate egress facilities are the education and organization of those responsible for fire safety, the provision of adequate alarms, and systematic attention to fire and exit drills.

There is necessarily a close interrelation between all of these various problems, and such interrelation should be borne in mind in reading the following sections of this article, which purposes to show the various common hazards which are found in institutional buildings and to outline the methods by which such hazards can be remedied or largely reduced.

The facts presented in this article are based upon investigations extending over a period of more than a decade, a detailed examination of many institutional buildings located in various parts of the country, and a careful study of the available literature on this subject.

Fig. 7. Thirty blind children sleep in this room, which has small windows affording very poor ventilation and useless as means of egress. The only doorway leads to open wooden stairs. Note the highly varnished woodwork. It takes no expert to prophesy another institutional catastrophe.

Causes of Fire.

Summary of Fire Causes.

The following table shows the number of institutional fires due to the various causes, as compiled by the Actuarial Bureau of the National Board of Fire Underwriters, occurring during the years 1916 and 1917.

Causes of Fire	1916 Number	Percent	1917 Number	Percent
Heat Hazards	119	20.0	129	21.3
Matches and Smoking	71	12.0	77	12.7
Lightning	67	11.2	54	8.9
Sparks	47	8.0	62	10.2
Electricity	42	7.0	47	7.8
Oils and Hazardous Materials	39	6.5	31	5.1
Gas	24	4.0	15	2.5
Spontaneous Combustion	17	2.7	18	3.0
Exposure	16	2.7	35	5.8
Open Lights	15	2.5	22	3.6
Incendiarism	11	1.7	8	1.3
Open Fires	16	2.7	0	0.0
Explosion	4	0.7	2	0.3
Housekeeping	2	0.3	3	0.5
Fire Works	2	0.3	3	0.5
Conflagration	3	0.5	1	0.2
Miscellaneous	18	3.0	20	3.3
Unknown	85	14.2	79	13.0
Total	598	100.0	606	100.0

The more important of these causes are discussed in the following sections.

Hazardous Materials.

Volatile Liquids.

In all hospitals and in many institutions of other types it is necessary to keep on hand considerable supplies of ether, alcohol, gasoline, and other inflammable liquids, and that they are a distinct fire hazard is borne out by some 6% of all fires being due to them. The main supply of these liquids should be kept in a small isolated building, or in a fire-resistive vault, provided with proper ventilation and drainage. Only small quantities should be taken into ward buildings and these should be handled with greatest care. See account of the Schoffner Hospital Fire number 26 on page 319. In some institutions it is customary to keep considerable quantities of these liquids in supply rooms on each floor, a practice which should be discouraged.

Great care should be taken in the handling of the supply of gasoline for motor driven ambulances, trucks, or pleasure cars. Gasoline should be stored in underground tanks, and never be handled in open containers. Gasoline should never be used for cleaning purposes, especially inside of buildings. The danger is acute. Static electricity may be generated in the cleaning process and is especially to be feared.

Many of the metal polishes commonly used for polishing brass work on ambulances and in buildings are highly inflammable, being composed largely of benzine or gasoline.

Naphtha and benzine are employed as solvents for rubber cement which is used commonly for mending rubber gloves, hot water bottles, etc. Cement should be kept in small quantities in covered cans. Such liquids should not, of course, be used in any portion of buildings occupied by inmates.

Oils and Paints.

A very generous supply of oils, paints, and varnishes is kept on hand at most institutions. These should never be stored or used in combustible buildings occupied by inmates. The main supply should be kept in an isolated storage house. In paint, machine, furniture, and printing shops, only the amount of oils and paints needed for immediate use should be kept on hand and these should be stored in a tight metal cabinet with a drip pan and self-closing doors. Alcohol and turpentine needed for thinning paints and varnishes or cleaning press rolls should be kept in approved safety cans. In a western state, 300 gallons of oils and paint were found stored with a large amount of lumber in the basement of a building housing deaf children.

Linseed oil mixtures are very frequently used for oiling floors. For this purpose mineral oil compositions are much safer, but the dressing of floors with any form of oil is a poor practice which should be eliminated.

In one large institution for insane, the floors were found oiled with a linseed oil mixture, the main supply of which was kept in a paint shop in the basement of one of the ward buildings. Oil-soaked sawdust and cotton waste lay about the floor and hundreds of gallons of oil, paints, and varnishes were stored in barrels, cans, and open containers. Some old

Fig. 8. The overfilled refuse can, the rags above, and the wooden ladder, all constitute a fuse leading to the wooden floor above.

furniture was placed near the door awaiting refinishing. In spite of the hazard, no extinguishing equipment was provided, and the only exit for the workmen here to the basement beyond was past piles of newly varnished furniture.

Dangerous Chemicals.

Chemicals dangerous from a fire standpoint are frequently found in institutional drug rooms. They should be listed and kept under lock and key in the safest place available.

Cotton.

Cotton wool, cotton gauze, flannelette, and cotton bedding are used in practically all institutions. Untreated cotton ignites from the slightest spark or flame, and burns very rapidly.

The storage of all supplies away from spark dangers and of large supplies outside of ward buildings is advisable.

Celluloid and Motion Picture Films.

Some institutions, especially convalescent hospitals, children's homes, and insane asylums, have motion pictures for the inmates at frequent intervals. The ordinary type of film ignites very easily, burns rapidly, and gives off stifling smoke. Only approved machines, properly installed in fire-resistive booths, and attended by licensed operators should be allowed. Slow burning or "safety" films are now on the market and should be given preference whenever possible.

Celluloid is similar in composition to motion picture films and articles made of it should not be allowed inside institutional buildings. It is especially apt to be found in the form of toilet articles, picture frames, toys, and even match trays, lamp shades, and candle sticks.

Housekeeping.

Cleanliness and order are, generally speaking, good in institutional buildings, but hazardous conditions are likely to exist in basements, attics, and workshops, and especial supervision and effort are necessary to keep these places clean.

Metal cans should be provided for rubbish and soiled cotton waste. All rooms in constant use should be swept daily, and any accumulation of combustible material in basements and attics should be removed at once. Especial attention should be given to the removal of papers and other packing material from grocery store rooms and supply rooms. All lockers and closets should be frequently inspected to prevent accumulations of old clothing and other combustible material.

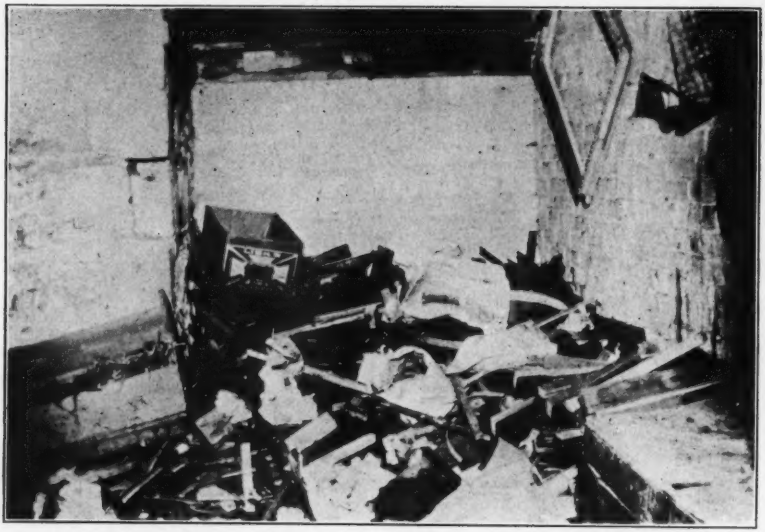


Fig. 9. The condition of the basement in an industrial home for girls. Rubbish, excelsior, waste paper, broken furniture, and only a wooden floor between this junk pile and an assembly room above which has inadequate exits.

Heating Hazards.

Boilers, Furnaces, Stoves, and Forges.

Heating equipment is responsible for more fires in institutional buildings than any other one cause, the proportion being over 20%. In small institutions, furnaces and boilers in the basement should be located in fire-resistive rooms. They should be set on non-combustible bases, and proper clearance should be provided between them and all woodwork. Wherever possible, heating equipment should be installed in a separate, non-combustible building, and needless to say, all heating equipment should be properly supervised.

A three-story stone, wood-joisted building was occupied as a home for old people and orphans. Heat was supplied by oil-fired boilers located in the basement. One boiler was improperly supported and fell, breaking a fuel oil pipe. A 16-year-old boy in charge of the fires became excited and pulled the switch extinguishing the lights, instead of shutting down the oil pump. The burning oil flooded the basement and five lives were lost. Had the boilers been in an isolated boiler house, the loss of life would have been prevented.

Very often the hotel type of ranges, which are not provided with legs, are found installed on wood floors, with little or no protection. All flooring under such ranges should be entirely of non-combustible construction.

Where institutions maintain a blacksmith shop, this should be well

away from other buildings. One instance was found where a blacksmith shop adjoined a hay barn with no protection available.

Chimneys, Stacks, Stove Pipes, and Steam Pipes.

All chimneys should have at least 8-inch brick walls and flue lining, except that for 1-story buildings with an ordinary stove a chimney having a 4-inch wall and a flue lining is permissible. All chimneys should be supported directly on the ground. Chimneys and stove pipes should be thoroughly cleaned each fall before fires are started. Woodwork should in no case be bedded in chimney walls, and proper clearance should be provided about all stacks, stove pipes, and steam pipes. Stacks should be provided with spark arrestors.

The danger of fire starting from the heat of steam pipes is not generally appreciated, and in many institutional buildings the steam pipes are found in contact with the woodwork of the floors and walls at many places. Sometimes wooden guards provided about radiators and steam pipes are in contact with the hot metal. In one institution for insane the radiators have been boxed in to serve as seats. The danger lies in the heat of the steam pipes converting the wood into charcoal which takes fire spontaneously. It is very important that proper air space be provided about all pipes, and that these be supported so as not to come in contact with woodwork.

Stove pipes should never pass through closets, attics, or other concealed spaces, should have proper air space between them and surrounding woodwork, should have all joints securely riveted, and should be properly supported.

Gas, Alcohol, Kerosene, and Electric Stoves.

Heaters of these types are used in dining rooms and nurses' quarters for warming dishes or for preparing special food. The hazards of the various fuels used in these heaters are discussed under separate headings. All such appliances, however, should be placed on non-combustible supports, with proper air space between them and all woodwork. Alcohol and kerosene heaters should be kept clean, filled outside the buildings, and used only when necessary. Electricity or steam is much safer. In many institutions small heaters of these types are used very freely, often under unsafe conditions. The number used should be limited to those actually needed, and these should be frequently inspected to see that they are in proper order.

Electric bed warmers, found for the most part in private institutions, should never be used. Warm bricks or hot water bottles are preferable.

Fire Places.

Where fire places are used, they should be very carefully safeguarded. At one state institution for feeble minded, open gas fire places were found in use. The hazard of such a condition is evident. Where fire places are permitted, close fitting screens should be provided and under no condition should hearths be placed over wooden flooring. Bedding should never be aired or dried before an open fire or close to a stove. Where rapid drying is desired, circulation of air by a fan is the safest method.

Laundries.

Fires have started from steam dryers in laundries, due to woodwork or clothing being in contact with the hot steam pipes. Clothes dryers should be of metal throughout, and steam pipes should be protected by wire screening. Gas mangles should be properly installed and the flames guarded. Where stoves are provided for heating irons, they should be carefully installed and attended.

Pilot lights should be installed in circuits to all electric irons, and current should never be left on when irons are not in use. Gas irons should not be permitted. Non-combustible stands, with at least 6 inch clearance, should be provided for irons when not in use.

Lighting.

Electricity.

Undoubtedly electricity is the safest form of lighting for institutional buildings, but, even where the original installation is good, there are many dangers to be guarded against. The percentage of fires from this cause is 7 out of 100. In many respects, electricity acts like water. Excessive voltage will break down insulation, as too high pressures will burst hose. Fuses, like safety valves, must be properly installed and maintained to prevent overloading. Kinks in wiring cause the insulation to break down, just as kinks will cause bursting of hose under pressure. Water, by gravity, seeks a common level and must be held within bounds; so electrical currents seek to equalize themselves and must be restrained by proper insulation. For these and many other reasons electrical installations should conform in every detail with the requirements of the National Electric Code. All hazardous electrical installations should be thoroughly gone over by a competent electrician and put in proper order. This condition should then be maintained by frequent inspection.

In one institution for insane, fire was caused by an inmate tearing an electric fixture from the wall.

Lamps, especially the gas-filled type, become hot enough to ignite woodwork, paper, or other combustible material with which they come in contact.

Wherever there is danger of this, lamps should be protected by wire guards. Paper or other combustible shades should be prohibited. Where lamps are hung on drop cords, these should not be tied or twisted, or allowed to come in contact with gas pipes, nails, or other metal.

Gas.

Swinging brackets should not be allowed where flames can possibly come in contact with curtains, woodwork, or other combustible materials. All exposed flames should be protected by wire guards or shields. Where clearance over lights is less than 2 ft., heat bells or other special protection should be provided.

Portable gas lamps should be avoided. If these for any reason are used, they should be of a type having a broad heavy base. Extensive tests conducted by the U. S. Bureau of Standards show that much of the flexible tubing now on the market consists simply of paper covered with some form of tar compound. Even with high grade rubber tubing, leaks are

likely to develop, or connections may become loose. The use of tubing for gas should therefore be prohibited, except where absolutely unavoidable, and only rigid pipe connections should be allowed.

Gas meters should be properly supported by non-combustible brackets and pipes above meters should be bridged with wire or metal bar to conduct electrical current to ground without passing through the meter itself. The use of lead pipe should be prohibited. A fire was caused in a state institution for insane by a lighted match being thrown into oil mops which stood underneath three gas meters. The burning mop melted a 2-inch lead gas pipe, and ignited the gas. Numerous explosions and heavy damage resulted before the gas could be turned off. Meters should be placed only at safe locations, away from all danger of fire, and sufficient valves should be provided to permit of immediately shutting off all supply of gas at time of fire.

Acetylene gas systems, if used in institutional buildings, should be in accordance with the rules of the National Fire Protection Association for installation and maintenance of such systems.

In children's homes and insane asylums, all flames should be out of reach of the inmates, and fixtures should be of a type requiring a special key to operate.

Kerosene Lamps.

The normal danger of kerosene lamps is greatly enhanced in some types of institutional buildings. One instance is recalled of a training school for blind children where kerosene lamps were in use, although electric lights were installed throughout. Another case was found where the frame buildings of an insane asylum were wired throughout for electricity but kerosene lamps of a poor type were in use and lanterns were kept burning for lighting pipes.

Where it is necessary to use kerosene lamps temporarily, care should be taken to see that the burners fit tightly, that wicks are of proper length and width, that lamps are kept clean at all times, and that they are filled outside of main buildings. Metal fonts are preferable to glass fonts as the latter are subject to breakage. Many bad accidents and fires have resulted from gasoline being used in lamps by mistake.

Where oil lanterns are used they should be of the railroad type, having metal fonts and wire guards about globes.

Lightning.

The efficacy of lightning rod protection properly installed is clearly established by the records of the National Board of Fire Underwriters, which show that of the 121 fires in institutional buildings which were caused by lightning in two recent years none were in buildings provided with standard lightning rod protection. Lightning rod equipment is now tested and approved by Underwriters' Laboratories, and such approved equipment should be provided on all institutional buildings located at high and otherwise exposed points, especially those of frame construction.

Matches and Smoking.

Smoking and careless handling of matches rank second only to heating equipment as a cause of fires in institutional buildings. One out of every eight fires is so caused. Safety matches should be used in preference to the "strike anywhere" type, and metal friction lighters should be used wherever possible for lighting gas lights and ranges. Irresponsible inmates should not be allowed to have matches in their possession.

Smoking should be strictly prohibited in buildings occupied by inmates, except at certain safe locations designated for smoking rooms. Even where smoking rooms are provided, inmates confined to beds are very likely to smoke surreptitiously, especially in convalescent hospitals, and such a practice should be guarded against. Attendants are often careless about smoking and the use of matches in their quarters, which are frequently located on upper floors of combustible buildings. Smoking in bed should be absolutely prohibited, and preferably no smoking should be allowed in main buildings.

Open Fires.

Rubbish, waste paper, and soiled dressings are frequently burned in open fires in the yards. Because of danger from flying sparks such material should preferably be burned under boilers or in properly constructed incinerators. Wherever necessary to build open fires, these should be carefully watched while burning and thoroughly extinguished before leaving.

Incendiarism.

In institutional buildings there is considerable danger of fires being started by vicious or irresponsible inmates. See account of fire number 48 at State Home for Girls, Trenton, N. J., on page 322. Inmates should be carefully watched for incendiary tendencies and opportunities for starting fires should be reduced to a minimum.

Fire Extinguishing.

To find a hospital, asylum, or similar building with an adequate amount of fire protection, properly maintained, and likely to be used intelligently at time of fire, all of which factors are vital, is a pleasure rarely experienced by the fire protection engineer interested in the subject. Dry powder tubes which have always been fire protection delusions, and equally objectionable hand grenades, still exist in our institutional buildings. Weak water supplies are connected to inside hose outfits, poorly maintained and insufficient in number. The maintenance of chemical extinguishers is frequently poor, and their operation, simple as it is, not generally understood by the staff. Outside hydrants and hose systems are usually so weak, inadequate and poorly understood, that while they may serve to extinguish a grass fire, there is no possibility of their extinguishing a real fire, especially one several stories above the ground.

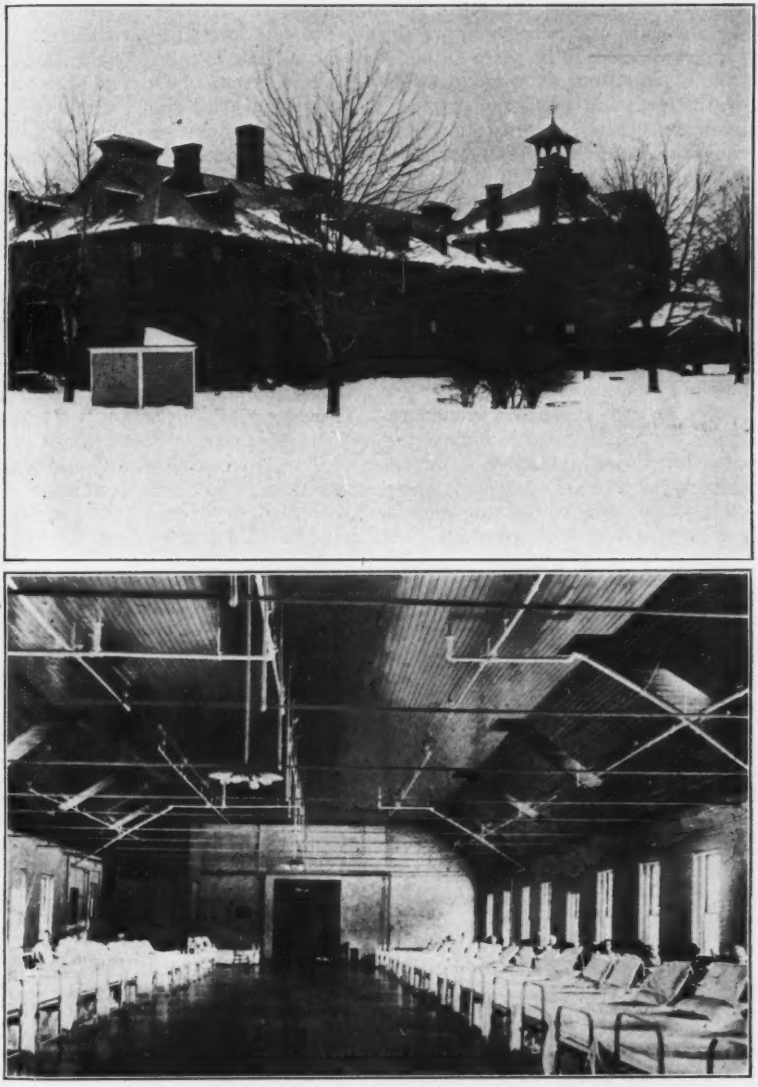


Fig. 10. An almshouse in Hartford, Conn. Old and combustible, but safer than many institutions because of its complete sprinkler protection. Note the sprinkler on the ceiling of the ward, and the hydrant house at the left in the upper picture.

In practically all institutional buildings, not absolutely fire proof, there is only one solution if practically complete immunity from life and property loss is to be assured, and that is the installation in whole, or in part, of an automatic sprinkler system. These systems have made a wonderful record in industrial plants and other properties, and their need is infinitely greater in institutional buildings. In a factory the occupants can walk out; in a hospital a handful of persons may have to bring a hundred into safety. In a factory there are many able-bodied men who can be used for fire fighting purposes; in many institutions the staff members are largely women and relatively few in number, and cannot be spared to fight a fire. The factories operate largely during daylight hours; institutions, every hour in the year. The average factory is a far better fire risk than the average institutional building. And finally, many institutions are outside of our cities and cannot depend upon public fire departments for rescue and fire fighting services.

It is safe to say that in practically every wholly or partially combustible institutional building, any substantial amount of money available should go into automatic sprinklers. Moderate additional sums are generally needed to provide hand extinguishing apparatus. With large isolated institutions, effective water supplies, both for sprinkler and hydrant service, large distributing pipe systems, hydrants, hose carts, ladders, and other fire fighting equipment are generally needed, all of which is a subject for investigation and report by technically skilled engineers.

Automatic Sprinklers.

Operating without human agency, ever on guard, quick to respond to the challenge of fire, and its proud conqueror in 35,000 battles, the automatic sprinkler system has earned for itself the premier place in the fight against life and property loss through fire.

An automatic sprinkler system consists of a series of pipes close to or concealed in ceilings and to which sprinkler heads are connected at intervals of 8 to 10 feet in both directions. These heads are made with a special solder which melts at about 160 degrees F., which is less than the boiling point of water. The sprinkler has a one-half inch orifice or nozzle, and a deflector, and under usual pressures will discharge from 15 to 20 gallons of water per minute in the form of a drenching spray over an area some 15 feet in diameter. With such spacing of heads, and their introduction into places under stairways, in closets, in ventilating ducts, etc., there is little chance for a fire to gain headway.

To date about 100 institutions have been protected in whole or in part by automatic sprinklers, a partial list by cities being as follows:

Boston, Mass.	16
New York City	6
Chicago, Ill.	5
Providence, R. I.	3
Rochester, N. Y.	2
Dorchester, Mass.	2
Roxbury, Mass.	2
Middletown, N. Y.	2

This means that only about 1% of our institutions have made a beginning toward adequate protection, for among these 100 institutions only a few are as yet adequately protected.

Fires Stopped by Sprinklers.

Already in some institutional buildings, experience with automatic sprinklers in fire has been registered, as indicated by the following typical examples:

Rhode Island Hospital, Providence, R. I. Fire started in a pile of mattresses in the attic. One sprinkler opened and extinguished the fire before it was discovered.

Winchester Home for Aged Women, Charlestown, Mass. Heat from boiler ignited woodwork. One sprinkler extinguished the fire with practically no loss.

Homeopathic Hospital, Rochester, N. Y. Fire started on roof and burned through. Automatic sprinklers in concealed space underneath the roof extinguished the fire with trifling loss.

Butler Hospital, Providence, R. I. Fire started in the assembly hall from a match or cigarette. One sprinkler extinguished the fire with little loss.

Any one of these fires could easily have developed into a holocaust. Contrast the safety that sprinklers give with the list of fires herein and with the way in which fire has laid low useful institutions of similar construction but without automatic sprinkler protection.

Value of Partial Protection.

While complete protection with automatic sprinklers in a combustible building is always desirable, sufficient funds frequently cannot be secured, especially at the outset, and hence, a wisely conceived plan of partial sprinkler protection, gradually extended as funds become available, is generally advisable. The proper procedure is usually as follows:

A. All institutional buildings within a given jurisdiction should be listed in the order of their relative danger to life, taking into account construction, exits, operations carried on therein, and any other essential factors.

B. Sprinklers should be provided in the basements of buildings, in the order of their standing on the relative hazard scale.

C. These systems should be arranged so that they can later on be extended to upper floors of the buildings.

D. Store rooms or other danger spots in even fire resisting buildings, should be included in such a list.

E. After all dangerous basements have been protected, the installation should gradually be extended upward, again beginning with the more hazardous buildings on the list.

In this manner, a given amount of money will be used most effectively, and ultimately all combustible structures will be fully protected.

It is a common habit of authorities to find that it would cost tens of thousands of dollars to install sprinklers throughout a large institutional building or a group of structures, and therefore to assume that because the whole sum was not forthcoming, no protection of this kind was

feasible. Installing sprinklers in a single dangerous basement is a very worth-while step.

An Opportunity for a Charitable Citizen.

The time will come when men and women of means, who are today giving generously to our hospitals or other institutions, will of their own initiative or at the suggestion of boards of governors, provide adequate fire protection, as a gift or bequest, instead of providing only for additional buildings, equipment, and operating expenses. The day will come when in Administration Building entrance halls will be found tablets reading:

> "The automatic sprinkler system, which assures those whom this roof shelters the maximum of protection against fire, is the gift of John Jones, Esq., generous giver to worthy causes, and long the friend of this institution."

Extinguishers and Hose Protection.

Soda-Acid Extinguishers.

The 2½ gallon extinguisher which operates by the action of sulphuric acid upon bicarbonate of soda is one of the most effective hand extinguishing appliances that can be placed in institutional buildings. Extinguishers of this type which have been tested and approved by Underwriters' Laboratories, should be provided in the corridors of all buildings and also in wards, except where there is danger of their being interfered with by irresponsible inmates. Especially should they be provided in all work shops, laundries, kitchens, storerooms, and other places of special hazards.

All employees should be drilled in the handling of extinguishers.

Extinguishers should be hung where they will be conspicuous and easily accessible, with the tops not more than 5 feet above the floor. In a home for deaf children where the only men present were the gardener and the engineer, the chemical extinguishers were hung so high that it was impossible for any of the women teachers and employees to take them down.

Large extinguishers of this type hold from 25 to 50 gallons, are mounted on wheels, and are provided with 50 feet of rubber hose. In the hands of trained men, such extinguishers can be used very effectively even when fires have gained considerable headway. They are especially valuable for large institutions or locations where the water supply is inadequate.

Foam Extinguishers.

Extinguishers of this type smother fires by means of a foam which they generate. They are designed especially for the extinguishment of oil fires, but are also effective upon fires in other materials.

Pump Type Extinguisher.

A 2½ gallons extinguisher which is especially suitable at locations where there is danger of freezing is equipped with a hand pump by means of which a stream similar in power and range to that generated by the

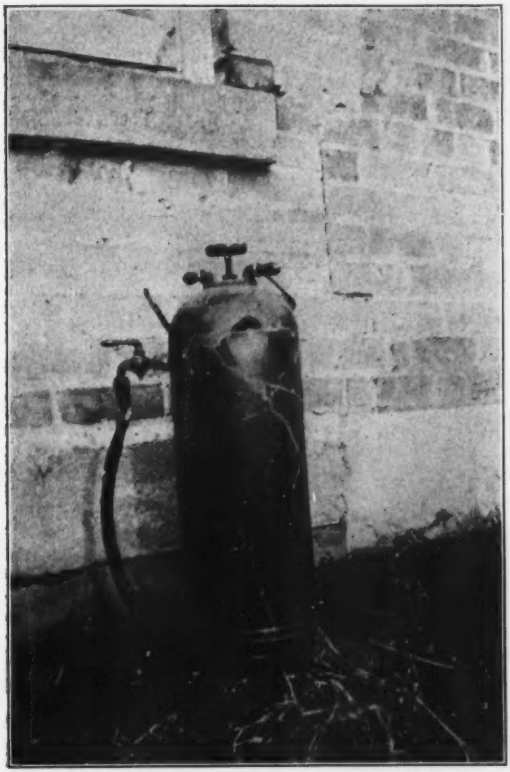


Fig. 11. A corroded fire extinguisher found in a state reformatory. Note the lead pencil stuck through the shell at the left just above the valve.

soda and acid type can be directed upon a fire. The water used in these extinguishers can be treated with calcium chloride to prevent freezing.

Another type of pump extinguisher is of two or three pint capacity and handles a special liquid composed largely of carbon tetrachloride. Extinguishers of this type are especially valuable for use on oil or electrical fires. The liquid is a nonconductor of electricity, and when played upon a fire forms a heavy gas blanket which excludes the oxygen from the flame. These extinguishers are not recommended for general use upon fires in wood, paper, and similar materials, but can advantageously be provided in switch and generator rooms, oil rooms, drug rooms, laboratories, and on motors, ambulances, trucks, and pleasure cars.

Water Pails.

Pails of water are the oldest, cheapest, and best understood of all fire extinguishing agents, but it is difficult for anyone, and especially for women or children, to throw water accurately or for any distance from a pail, and water pails should not, therefore, be substituted altogether for chemical extinguishers, with which fire can be reached at high points. Water pails, however, should be liberally installed in basements, attics, workshops, barns, and other places where they can be effectively used. Pails should be of 12 quart capacity, painted red, and stencilled "FOR FIRE ONLY," filled with clean water, and regularly inspected. Wherever there is danger of freezing during cold weather, the water should be treated with a proper quantity of calcium chloride. In places where large quantities of water may be needed, it is well to provide one or more casks

filled with water, and to place the pails either above or inside of them. Protection of this sort is easily available to everyone at slight cost, and there is little excuse for such conditions as were found in an insane asylum, composed of numerous frame buildings, where not even water pails were provided, and where water was shut off throughout the property at night to prevent wasting.

Sand Pails.

Pails of clean, dry sand should be provided where there is danger of fire in oil or electrical equipment, and should be equipped with scoops having wooden backs and handles, for scattering the sand effectively. Sand should not be used, however, upon motors or other machinery because of injury to bearings.

Dry Powder Tubes.

Metal tubes filled with bicarbonate of soda are found in many of the older institutional buildings, and are practically valueless and should be discarded. Bicarbonate of soda has only slightly greater extinguishing value than ordinary dirt, sand, flour, or other finely divided incombustible material which can be used to smother flames. At the start of the Iroquois Theatre fire, an attendant wasted time in endeavoring to use a dry powder extinguisher, and 600 lives were lost as a result.

Hand Grenades.

Hand grenades or bottles filled with water or special extinguishing liquids are of as little value as the dry powder tubes and should be discarded wherever found.

Inside Hose Protection.

For fires discovered in the incipient stage, chemical extinguishers, water pails, and similar equipment are generally adequate. With buildings of ordinary construction, when fires have gained any considerable headway, powerful streams from outside hydrants alone will be effective. Between these two stages, there is occasionally a time when inside hose equipment proves very useful. One or two ½ inch to ¾ inch streams can put out a fire of considerable size.

There are, however, several arguments against the use of inside hose in institutional buildings, chief among which is the fact that when fire has gained sufficient headway to require the use of hose, it is time for everyone, except experienced firemen, to be engaged in getting patients out of the buildings. This is one reason for the emphasis given to automatic sprinkler protection in this article.

In modern multi-storied fireproof buildings, however, a good standpipe system may be sufficient hose protection, no appreciable amount of outside hose being required.

Even where inside hose is provided, its efficiency is frequently lessened by the manner in which it is installed and maintained. Hose hung over pipe connections in a tangled manner, or otherwise not quickly available for use, nozzles missing, and hose wet because of leaking valves are conditions frequently found. Unlined linen hose rots quickly when wet, and such hose should never be used except in case of fire. Inspection should be relied upon to determine its condition.

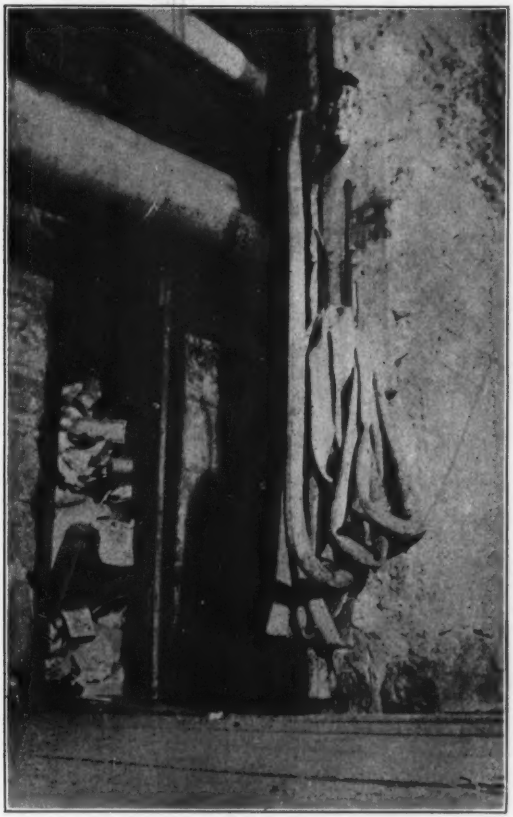


Fig. 12. The condition in the sub-basement of a school for the blind. Note the overfilled rubbish chute with wooden door, standing open, and a fire hose improperly hung, partly filled with water—certain to kink badly when used.

Where installed, water supply and piping should be sufficient to give at least 25 pounds pressure at the highest point, and hose should be so located that every point inside of the building can be reached by one or more streams.

Outside Hose Protection.

As with inside hose, outside hydrants and hose are of value only when there are persons present capable of handling them efficiently. Such protection generally is needed only for institutions outside of public protection zones.

The details of the water supply, pipe lines, and control valves should, of course, be thoroughly understood by those who use the hose. Special care should be taken to prevent freezing of hydrants and mains during cold weather. The fire at the Kansas Masonic Home, Wichita, Kansas, which caused the loss of five lives and $250,000 worth of property, got beyond control because the water mains were frozen and useless.

In the case of rural institutions covering hundreds of acres, some type of motor fire apparatus is generally needed, capable of carrying chemical tanks, hose, other minor accessories, and about six men. In one institution for insane covering about a thousand acres, a horse drawn hose and chemical wagon is kept in a barn, at least one-quarter of a mile distant from the main buildings. It is therefore of no use for carrying the men to fire and would only be available when some one had run the quarter of a mile to the barn, harnessed the horses and driven back to the

Fig. 13. Homeopathic State Hospital, Rittersville, Pa., showing excellent type of horizontal exit. It could be improved by making provision to use the passageway roof as a third story horizontal exit.

fire. Equipment treated in this manner is of value chiefly as a point of interest to visitors.

Fire Brigades.

At all institutions where good public protection is not available it is important that fire brigades be organized and carefully trained. It should always be borne in mind, however, that in institutional buildings, fire fighting must come second to life saving. In some institutions, a portion of the inmates are capable of rendering valuable aid, and this should be utilized in planning the exit and fire fighting organizations. In hospitals, the safety corps having charge of egress should be made up of doctors, nurses, porters, and attendants, while the fire fighting brigade should be composed of the chief engineer, his assistants, mechanics, yard men, and kitchen men.

The duties of the safety corps should be to respond to all fire alarms, treat and control patients, and remove them to places of safety when necessary.

The duties of the fire fighting force should be to respond to all alarms, use extinguishers, hose, and other equipment to best advantage, and, in emergency, assist the safety corps in removing persons from buildings.

Details of the organization must, of course, be worked out to fit local conditions at each institution. All members of the safety corps should be able to turn in a fire alarm properly, and to use extinguishers on incipient fires. The organization of both safety corps and fire fighting force should be clearly shown and the detailed duties of each member clearly stated on signs posted at conspicuous locations throughout the institution. These signs should also give information concerning the location and operation of fire alarm boxes and extinguishing equipment.

The fire fighting force should generally be in charge of the chief engineer, while the head doctor or head nurse should take charge of the safety corps. The superintendent of the institution should, of course, direct all activities as necessary, but he should be careful not to interfere with work which is already being efficiently carried out. At institutions where there is a scarcity of men, arrangements can sometimes be made with neighbors to respond to fire alarms and assist in the work. For the many institutions which are almost completely managed by women, arrangements of this sort are very important. Directors, visiting physicians, and others connected with institutions should be notified promptly at time of fire.

Means of Egress.

It is difficult enough to secure adequate egress facilities in factories or other buildings where the occupants are physically fit and mentally competent. The problem in buildings housing the sick and otherwise incapacitated is infinitely harder. The conditions in institutional buildings generally are bad, frequently deplorable. The reason the life loss is not greater than it is does not lie in good buildings, adequate exits, good alarm systems, adequate fire protection, and trained staffs, but in the fact that such buildings are used continually, and fires are likely to be discovered in their incipiency, and in that nurses and other attendants have shown remarkable heroism at time of crisis.

It is the difficulty and the expense of providing even reasonably adequate egress facilities in the ordinary institution that causes such emphasis to be placed in this article on fire prevention and on the installation of automatic sprinklers, for with such an installation properly maintained, the chance of a fire getting to the point where it jeopardizes life is exceedingly remote.

The egress problem varies with the building construction, and what will answer for a fireproof ward building will not do for a tinder box serving the same purpose. It also varies with the character of the occupancy. Tubercular patients able to walk and in full possession of their faculties present quite a different problem from incarcerated insane.

Closely allied to egress facilities, of course, is the question of the safety corps, as they have been termed in a preceding section of this article.

Some general comments and specific ones on certain classes of institutions are presented in the following sections:

Egress in Name Only.

In a western institution, the only means of egress from a chapel seating 800 people and located on the third floor of a combustible building was through three narrow doors located at the rear of the chapel and leading to an open wooden stairway. All of the windows were barred.

At one large industrial school for girls, all girls were locked in their rooms on the upper floors of a combustible building throughout the night, the only protection against fire being dry powder tubes and hand grenades. Moreover, the basement of this institution contained considerable quantities of oil, grease, gasoline, and combustible materials generally.

The dormitory shown in Figure 7 is located on the upper floor of an

institution for blind children. All woodwork is highly varnished. Thirty of the children sleep in the midst of this kindling pile, from which the only exit is the door shown at the far end of the room which leads to an open stairway. The windows are so small and high as to be useless for exits.

In one of the most modern institutions for insane in this country, the nurses were found quartered on the third floor of a combustible building at the head of an open stairway with no other means of egress. These conditions are typical of those existing in hundreds of institutional buildings.

The Need of Drills.

In institutions housing children, some attention is usually given to egress facilities and fire drills. The idea seems prevalent, however, that when persons have passed beyond the school age, they are beyond the need of fire drills, and consequently spend the remainder of their lives, wherever they may be, in absolute ignorance as to what action they should take at time of fire. This is the present condition of thousands of aged, blind, deaf, sick, crippled, and insane throughout the country.

Institutions for the Insane.

In institutions for the insane, the uncertainty of control at time of fire is still further complicated by the practice of keeping violent inmates under restraint, generally at remote locations on upper floors, where, behind locked doors, they are kept in straightjackets, camisoles, cuffs, etc. Restraint of this kind is generally used most freely in institutions managed by women. In one institution, 77 inmates were found restrained in this manner at one time. See account of fire No. 34 on page 320. Obviously, such patients should be located in the safest buildings, and on the ground floor, if possible, to permit most readily of rescue.

Location of the Helpless.

It is evident that in small institutions, a very definite effort should be made to have places of assembly such as chapels, dining rooms, and recreation rooms, located with special reference to ready egress, which almost always means the ground floor. Similarly, the seriously sick and the small children should be on the ground floor, if possible.

Much can be done in the ordinary institution along these lines to improve safety to life without any appreciable expenditure of money.

Doorways.

While for individual rooms, doors generally open inward, for larger assembly rooms, it is universally advisable that doors swing with the travel, and that care be taken to see that they do not obstruct corridors when opened.

Doors should be kept unlocked wherever possible. In one asylum for the insane, as many as five locks, all different, have been found between inmates and exit to the outside, three of which locks were unnecessary for adequate control of inmates.

The minimum number of locks, standard keys, as wide a distribution of keys as necessary, and constant attendance are the chief means of

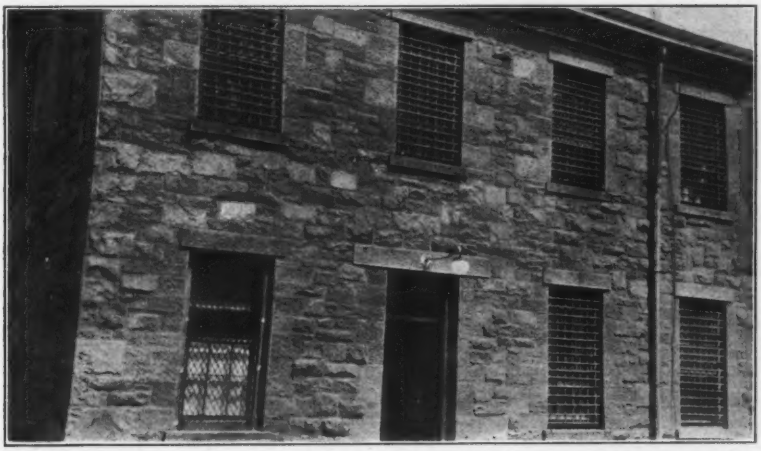


Fig. 14. A state hospital housing insane men on both floors with unnecessarily heavy bars on windows and with a single door the only exit.

making the best of a fundamentally bad condition. This of necessity pertains when persons are under lock and key in buildings not absolutely incombustible in every sense of the word.

Windows.

Most fire escapes, as at present installed, are reached through windows. Firemen use windows very often for rescuing persons and for fighting fires inside of buildings. In spite of this, in many institutional buildings windows are covered by screens, ranging from light wire mesh to heavy iron bars set in the masonry. In many cases, substantial protection is necessary on some windows to prevent escape of inmates, but there is no excuse for such massive window bars as those shown in Figure 14. There are cases on record where persons have been roasted to death behind bars of this kind, while firemen outside were helpless to aid them. Where necessary, window screens should be of heavy wire mesh set in a rigid removable metal frame, secured by a lock on the inside, but capable of being opened from the outside without a key. Windows should be of ample size, with sills low enough to permit of their use as exits.

Corridors.

In the dark, or smoke, or under panic conditions, passage through corridors may prove difficult or impossible. Corridors should, of course, be wide enough to accommodate all who will use them at one time under any condition. They should further be kept absolutely clear at all times, especial attention being given to the removal of wheel chairs, spare cots, and other obstructions which are apt to be left temporarily in the corridors. Under certain conditions, especially in extensive corridors of combustible buildings, it is advisable to provide smoke barriers and draft stops, consisting of light partitions and swinging doors, at various intervals to retard

the spread of smoke and flame for a sufficient period to permit of safe egress.

Horizontal Egress.

The most practical provision that can be made for egress in institutional buildings is an arrangement for moving occupants rapidly and in an orderly manner horizontally through fire walls or fire-resistive corridors, or across open bridges, to buildings or sections which are safe. Where buildings are large, they can be sub-divided by standard fire walls equipped with automatic fire doors, thus dividing the building into two or more separate sections, with little danger of fire communicating from one section to the other before all occupants are safely out.

Stairways.

In the majority of present institutional buildings, all floors are connected by open stairways, which may serve as flues for the rapid spread of smoke and flames. When fire occurs on the lower floors of such buildings, the stairways are quickly made impassable. The stairs themselves are often of stone or metal construction, cleaned frequently with oil, and very slippery. Handrails, if provided at all, are seldom at both sides of the stairways.

As far as possible, in new buildings, stairs should be located in fire towers. In all existing combustible buildings, open stairways should be enclosed in fire-resistive partitions with fire-resistive doors, held open, if at all, by a fusible link arrangement, which will insure prompt closing at time of fire. At least two fire towers or enclosed stairways should be accessible from every portion of each building.

Ramps.

While by no means generally used, the ideal method of moving helpless persons downward, whether wheeled on beds or carried on stretchers, is on a system of ramps or sloping walkways, surfaced with cork tiles or other non-slipping materials. A slope of 1 foot in 6 feet or 8 feet is practical.

Smokeproof Towers.

Wherever possible, both in new buildings and in existing buildings, standard smokeproof towers should be provided. Stairways completely enclosed in fire-resistive towers and commonly known as Philadelphia fire towers, provide the safest means of downward exit for able-bodied persons. Entrance to such towers is by open air balconies on each floor, with fire doors on the openings to prevent spread of smoke and flame.

In many of the present institutional buildings, including even the most modern, stairways are enclosed in fire-resistive walls, but doorways at the various floors are of wood, often with glass or open transoms above. Stairways of this type offer only a small portion of the safety assured by standard fire towers.

Fire Escapes.

In an industrial school for girls, entirely of frame construction, the only means of exit from upper floors was by one narrow open stairway and a vertical iron ladder on the outside of each building. This could be

Fig. 15. A spiral chute fire escape with platforms rusted through, on a four story combustible building housing several hundred feeble minded boys.

reached only by climbing over the railings of the iron balcony after passing through the chambers of institution officials, the doors of which were kept locked at all times.

In a western institution for the blind, the only exit from upper floors was by means of open wooden stairways or by vertical iron ladders on the outside of the building. In another western institution fire escape doors were found locked and could not be opened.

In a four-story combustible building, housing hundreds of feeble-minded children, an enclosed spiral metal chute on the outside reached to the top floor and was connected with each floor by narrow metal walk-ways which had rusted through and were so weakened that children could fall through to the ground below. See Figure 15.

Conditions similar to these exist in hundreds of institutions throughout the country. Some escapes, to be sure, are wide and properly railed; the stairs have an easy pitch; access to them is direct; they lead to the ground; they are located opposite blank walls or adjacent windows are protected with metal frames and wired glass; they are a valuable means of egress if used. A large majority of fire escapes, however, are a delusion; they may prove death traps. Narrow, steep, reached by climbing over window sills, terminating many feet from the ground, passing windows out of which flames are likely to pour, never used at times of drills, if indeed drills are held, they are a monument to the ignorance of the authorities and the selling ability of the manufacturers. An outside fire escape on an institutional building is generally an admission of the inadequacy of its normal exit facilities.

Adequate exit in new buildings should always be secured without resorting to fire escapes. On many existing buildings, however, fire escapes are necessary because of the inadequacy of the inside stairways. Where necessary their construction and installation should be in accordance with the National Fire Protection Association rules, and with special regard to the type of institution to be protected.

Fire escape stairways should extend to the ground. Where for any reason it is not possible to do this, a counterbalanced section should be provided. Figure 16 shows a fire escape which is a mere pretence.

Fire escapes should be kept unobstructed at all times and this condition verified by frequent tests and inspections. Painting is necessary to prevent corrosion, and by making the escapes the same color as the buildings, they can be rendered quite inconspicuous. Escapes should, of course, be kept free of ice and snow.

For able-bodied and responsible persons, especially officials, nurses, and attendants, individual automatic fire escapes from sleeping rooms

may be desirable under certain circumstances. Such escapes consist of a length of steel cable long enough to reach the ground and having a life belt at each end. The cable runs through a steel pulley which is provided with an automatic speed regulating device to prevent a too rapid descent.

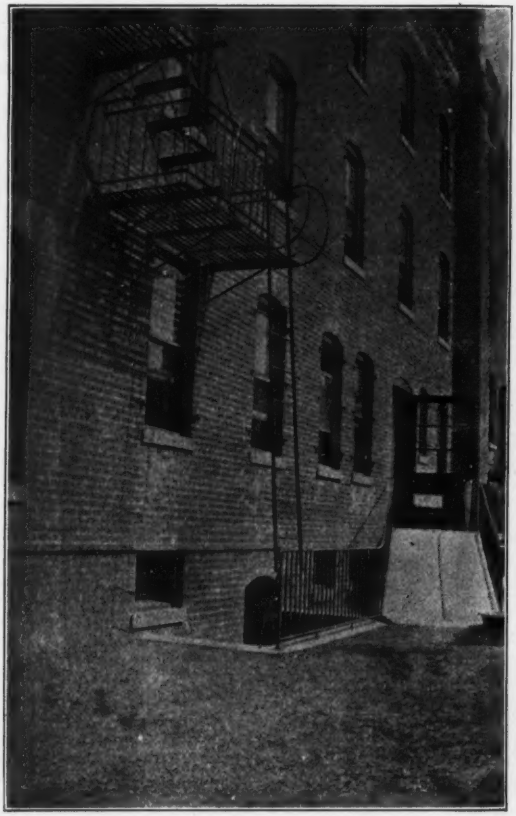


Fig. 16. A fire escape on an eastern hospital with an inadequate drop ladder, terminating over a basement areaway.

Signs and Lighting.

Red and white exit signs, with letters at least 5 inches high and illuminated at night should be placed over all stairways and doors leading directly to the outside. Exit signs should not be omitted over doors leading from roofs and basements. The current for exit lights should preferably be obtained from a system separate from that ordinarily used for lighting purposes. It is also well to provide auxiliary gas lights for use in case the electric service is interrupted.

Fire Signaling Systems.

Public Alarm Connections.

Wherever public protection is available, a fire alarm box should be installed at the institution so that the department can be summoned without delay. Even where the institution is located some distance outside the range of public protection, arrangements can generally be made to have the department respond in case of fire.

Private Alarm Systems.

If the institution is of considerable size, and especially if a trained fire brigade is organized, a private fire alarm system should be provided with boxes located at advantageous points throughout the property, and

with gongs so placed as to be heard by officials and members of the brigade. Certain types of private fire alarm systems can be connected to the nearest city box so that the operation of any one of the private boxes will also send the alarm to the city department. When drills are held, the connection to the city box can be temporarily cut out.

It should be remembered that the most elaborate protective equipment is of little avail if notification of fire is not given promptly. Some of the most disastrous fires in institutional buildings have resulted from delay in sending in alarm. In an orphan asylum fire at Texas City, Texas, six sisters and three children were killed and three servants were badly injured. One hundred little children were in the building at time of fire, and in the excitement in getting these out, no one thought to send in the fire alarm. A butcher, two blocks distant, finally turned in the alarm, but when the firemen arrived, there was little that they could do beyond holding life nets.

Telephones.

Because of the possibility of error and delay, the telephone method of sending an alarm is unreliable.

Sprinkler Alarms.

Where automatic sprinkler systems are installed, water flow alarms which operate automatically when a sprinkler head opens can be arranged to serve all fire alarm purposes. The great advantage of such a system when properly installed, is that the alarm is given and water is poured upon the fire simultaneously at the very start.

Thermostats.

Where automatic sprinklers are not provided, thermostats or automatic alarm systems, operated by the rise of temperature when fire starts, can be employed to give similar alarm service without, of course, the extinguisher feature. Prompt notification of fire outbreak is of importance second only to automatic extinguishment.

Notifying Inmates.

The necessity of notifying inmates when fire is discovered will depend largely upon the location and seriousness of the fire and upon the character of the inmates. Sick, nervous, or feeble-minded people should not be alarmed unless there is real danger, but the danger line should be clearly understood and there should be no delay when this is reached. For such persons, the alarm can be given by use of soft-toned bells or lights, and the latter can be used to advantage with deaf inmates. Boxes and gongs in each individual building should be on separate circuits arranged so that when an alarm is turned in from a certain building, all occupants of that building, as well as officials and members of the fire brigade where they are normally to be found, will be notified without alarming the inmates in other buildings.

Fire Drills.

Fire drills are not usually required in institutional buildings, either by law, local ordinances, or institutional rules.

In institutional buildings a large number of the inmates are confined to a certain portion of a certain building. At time of fire their only thought is to get out of the building by the usual way. If this is cut off by smoke, flames, locks, or other obstructions, they are very apt to become panic stricken. The majority of inmates are physically or mentally below normal. Many of them are helpless. Even where this is the case it is often true that throughout the night there is but one attendant to fifty or seventy-five inmates.

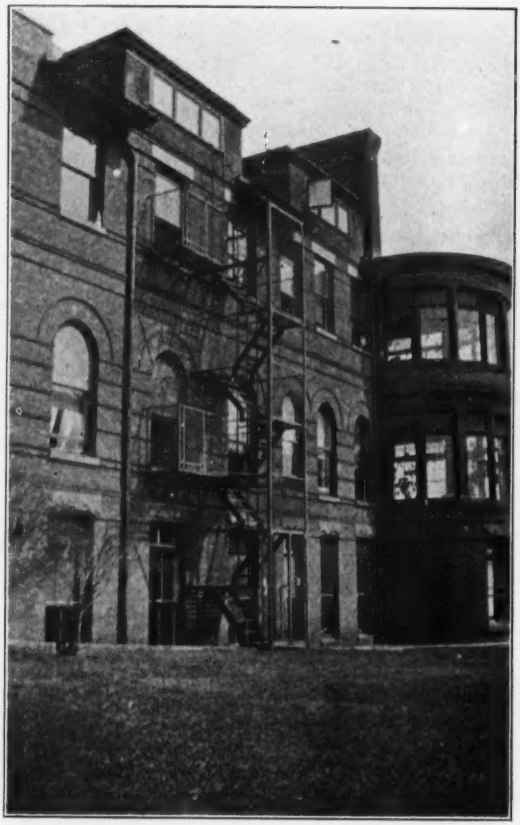


Fig. 17. A hospital fire escape, fair as regards pitch of stairs and good as to screen enclosures, but containing so many 180° turns as to be useless for carrying down patients on stretchers.

Fire drill should be held at least once each month in every institutional building. The details of the drill will necessarily vary with the type of institution, and some discussion of special details will be found under the various headings on pages 356 to 359. Where the mental and physical conditions of the inmates allow it, they should be instructed regarding action to be taken at time of fire alarm and should be drilled to vacate buildings in orderly manner without special supervision. Where inmates are mentally defective, the prime need is for cool and competent supervision. With the sick or crippled, physical assistance and reassurance are needed.

The details of fire drill should be carefully worked out and the proper arrangements made to meet all possible emergencies. Ultimately, drills should be held at various times of day and night, and, in certain types of institutions, without notice.

For Fire Brigade suggestions see page 342.

Fire Spread.

Most institutional buildings are of highly combustible construction and present large areas with absolutely no provision for checking spread of smoke and fire, which can communicate between floors by means of open stairways, elevator shafts, dumb waiters, clothes and rubbish chutes, and various other openings. The ordinary wood joisted institutional building is a potential furnace, with masses of wood, dry as tinder, enclosed in oven-like walls. The speed with which fire spreads in such buildings is often appalling. Brick or stone walls add practically nothing to the safety of a building with a wooden interior, as evidenced by various illustrations in this article.

New Construction.

New institutional buildings should be of fire-resistive construction throughout, and where possible, of but one story in height. Buildings should be separated either by standard fire walls or by at least 50 feet of open space. All floors of adjoining buildings should be connected by fire-resistive corridors or by openings through fire walls protected by standard fire doors. In rural communities the general use of one story buildings is quite feasible, but in the larger cities where land is scarce it is necessary to build higher. Every effort, however, should be used to house the sick, the crippled, the blind, the deaf, the insane, and others wholly or partially helpless as close to the ground as possible.

Existing Buildings.

Over 90% of existing institutional buildings are of frame or wood joisted construction. The need therefore is for immediate action toward the improvement of these buildings. An intelligent examination of even a limited number of institutional buildings will convince the most skeptical of the present danger.

One four-story wood-joisted building was found filled with blind children and their teachers. The only protection provided was inside hose and the water pressure was insufficient to reach the upper floors. A paint shop was located in the basement and rubbish chutes from the basement communicated with upper floors.

A four-story, brick, wood-joisted hospital was found completely filled with bed-ridden patients. Two open stairways led from basement to top floor. All woodwork was old, dry, and heavily varnished. The only men found on the property were the engineer and a visiting doctor. The hospital was managed solely by women, many of whom were physically feeble. In case of serious fire on the lower floors, large loss of life was a foregone conclusion.

The only remedies for such conditions are radical structural changes, or the installation of automatic sprinklers, or a combination of both. It is criminal to place all dependence upon a few extinguishers or fire escapes.

The following type of structural improvements are of value in combustible buildings:

A. Subdivision of buildings by means of standard fire walls or partitions.

B. Enclosure of all floor openings such as stairways, elevator shafts, dumbwaiters, rubbish and clothes chutes, etc., with fire resistive partitions and doors.
C. Construction of fire resistive floor, walls, and ceiling about heating apparatus.
D. Protection of entire basement ceiling by metal lath and plaster. This gives considerable protection against fire; sheet metal nailed to joists does not.
E. Elimination of wooden shingle roofs.

Fire Walls and Partitions.

Sometimes in large buildings it is possible to make fairly effective fire walls of existing walls. Unnecessary openings can be bricked up, walls can be carried through the attic and roof, timbers which originally passed through walls can be cut off so as not to create continuous combustible channels through the walls, and necessary fire doors can be provided. Generally, if improvements of this kind are undertaken, it is possible to do the work in such a way that it will have distinct property saving value, and not merely give somewhat greater life protection.

In some combustible institutional buildings of large area the only proper treatment is to build one or more effective fire walls across the building. Some of the large public and private institutional buildings in the country are hundreds of feet long, the equivalent of five or six floor levels in height, and literally without any semblance of a fire stop either horizontally or vertically. Such conditions in a factory or mercantile property would be considered little short of an economic crime, and it certainly is quite as desirable that the same steps which would be taken in a business building be taken in a building housing hundreds of persons, many of whom are helpless.

Stairways and Elevator Shafts.

In existing buildings where it is not deemed advisable to provide standard fire towers and fire resistive shafts for elevators, stairs and shafts should be properly enclosed. Expanded metal and plaster partitions, or metal and wired glass, generally are satisfactory for this purpose. The doors leading to the stairs should normally be kept closed and should not be too heavy.

Heating and Ventilating Systems.

Heating boilers should almost without exception be located in a fireproof room, if not in a detached building.

The flues and ducts of heating and ventilating systems provide ready means for rapid spread of fire. Especially is this true where housekeeping is not of the best, as dust and lint are apt to collect in such places very rapidly. See Figure 18. All flues and ducts should be of metal or other non-combustible material. Foul air ducts should never terminate at the attic floor level, but should be carried through the roof. Ducts, flues, and pipes of heating and ventilating systems should be kept clean at all times, and wherever these pass through floors or fire walls, they should be equipped with automatic dampers which, through the melting of a fusible

link and the action of closing weights, will cut off the spread of any fire which occurs in or gets into them.

So widespread is the use of motor ambulances, trucks, and pleasure cars at institutional buildings, and so severe are the fire hazards involved, that special attention should be given to the provision of safe storage space. Wherever possible, garages should be isolated from main buildings and should always be of non-combustible construction. Where, as in congested districts of cities, it is necessary that garages adjoin main buildings, they should be of fire resistive construction throughout, with no direct connection to main buildings. Adjoining buildings should be properly protected against exposure.

Shingle Roofs.

The biggest factor in preventing exposure fire from affecting institutional buildings is to eliminate wooden shingle or other combustible roofing. Shingle roofs are objectionable also because sparks or brands from the chimneys of the building itself may set fire to the roof. No existing shingle roof should be permitted to be repaired extensively with wooden shingles. Various approved forms of fire resistive roofing materials, weighing about the same as wood shingles, may be installed without appreciable difference in cost.

Legislation, Inspection, and Instruction.

Legislation.

But little legislation has thus far been enacted for the improvement of fire protection and safety of life in institutional buildings, and existing requirements are often made indefinite by the use of such terms as "sufficient," "proper," "ample," "necessary," and "suitable." This commonly places the responsibility for interpretation upon untrained persons, and among these there is much disagreement as to proper procedure. In the face of the opposition and differences of opinion encountered, it is exceedingly difficult for fire marshals, fire chiefs, or any others interested in the matter to secure proper enforcement of the laws.

A notable legislative effort toward protection of institutional buildings in one of the most progressive states requires that all such buildings "shall be equipped *either* with an automatic sprinkler system *or* with an automatic fire alarm system." This gives a choice between the best fire fighting system (which combines with it also alarm service) and purely automatic alarm service. Valuable though the latter is, there is no comparison possible between the two systems. In many cases the requirements of the law will be met by the installation of the automatic fire alarm system, purely because of the difference in cost.

One important need is for the establishment of standards for new buildings. This can be most easily and satisfactorily met by adopting the recommendations embodied in the building code of the National Board of Fire Underwriters, copies of which can be secured from that organization, at 76 William St., New York. Standards must also be established for such matters as housekeeping, guarding of special hazards, egress facilities, fire drills, and extinguishing equipment. In the preparation of such

standards the data available through the National Fire Protection Association will fill practically every need.

Many of the deficiencies in present legislation regarding protection in institutional buildings may be met by proper use of the authority vested in state and city fire marshals, fire chiefs, and other officials. If all such officials were to use this authority without fear or favor for the best interest of the people, and were their decisions properly sustained by the law, much improvement could be made in a short time. Of special interest in this connection is the action of the Chicago municipal court and the Illinois supreme court in finding liable the Washington Home for neglecting to obey an order to install automatic sprinklers. This was a home for inebriates accommodating over one hundred patients. The contention of the management was that the city ordinance which required the installation of automatic sprinklers was a violation of the federal constitution. The courts ruled, however, that it was a reasonable exercise of police power and the ordinance will be enforced.

Fig. 18. A wooden dust covered ventilating duct in a building housing many children. Fire spreads through such ducts with terrific speed.

Inspection.

Even where the best of conditions have been established, frequent inspections are necessary for their proper maintenance. Where conditions are poor, frequent inspections are even more necessary in order that these hazards may be kept at a minimum. A chief engineer or other competent man at each institution should make inspections at least once a week covering at least the various up-keep matters presented in this article. In addition to such inspections there should be more detailed inspection, preferably twice a year, by expert fire prevention engineers.

Members of the public fire department should also make frequent visits to institutions in order that through knowledge of conditions they may be able effectively to handle any situation that may arise. Superintendents and doctors should also have fire protection in mind when making their regular rounds.

Watchman service should be provided at every institution, and each floor of each building, as well as the outside grounds, should be covered hourly by a watchman throughout the night. Such a man should be of a high type as regards character and ability, and should be carefully instructed regarding the proper action to be taken under any conditions which may arise. He should be well informed regarding fire hazards and the location and operation of fire alarms and fire equipment. Watchmen should follow a definite route in making their rounds and should register their movements on recording clocks. A detailed report of conditions should then be made out and delivered to the superintendent each morning.

Instruction.

All officials, doctors, nurses, attendants, and other employees at institutions should be carefully instructed regarding common fire hazards, the use of extinguishing equipment, and the method of sending in a fire alarm. Following fire drills, these matters should be discussed with all such persons, especial attention being given to the instruction of new employees.

Special Occupancies.

Emergency, Acute, General, and Maternity Hospitals.

In these institutions the inmates are largely helpless but mentally alert, and every effort should therefore be made to prevent alarm or excitement among the inmates at time of fire. Fire alarm signals should be given by means of colored lights, soft toned bells, or other special means.

The majority of inmates being unable to walk must be moved by nurses and attendants. To carry a stretcher or mattress requires at least two persons and takes considerable time. When stretchers are used, inmates must be handled twice, and especially in the case of operative patients, this is apt to result seriously. It is practically impossible to carry patients either in stretchers or on mattresses down fire escapes and difficult even on the easiest stairways. To pass through doorways takes considerable time. The following points therefore seem very important:

1. Patients should *not* be taken from their beds.
2. The beds, with the patients in them, should be wheeled horizontally through fire walls or fire resistive corridors, or, in the case of isolated buildings down ramps to the ground.

This leaves the stairs or fire escapes clear for the use of firemen. In all wards, the most helpless patients should be placed nearest the exits. Beds should have casters not less than 4 inches in diameter, those at one end of the bed being fixed and at the other of the swivel type. At time of fire or fire drill, the doctors, nurses, and attendants of the safety corps should wheel all beds to a place of safety. Under the worst conditions, each person should be able to wheel beds to safety at the rate of one every three minutes. Fire ramps, where necessary, may be built to connect

porches already provided. A straight ramp from each ward is preferable however.

Where for any reason it is necessary to use stretchers, a generous supply of these should be provided. They should be strong and light, should be kept at a conspicuous central location, and should be designated "FOR USE AT TIME OF FIRE ONLY." They should be considered a part of the fire equipment and other stretchers should be used for ordinary purposes.

The advisability of sounding fire alarms and removing inmates from buildings for drill purposes in certain types of institutions is debatable. During pleasant weather, or where provision is made for safe egress without exposure, this can usually be done if helpless and nervous inmates are previously notified of the drill and the absence of danger. Where this cannot be done the fire brigade and safety corps should be organized, frequently instructed, and drilled to whatever extent is practicable, with especial care.

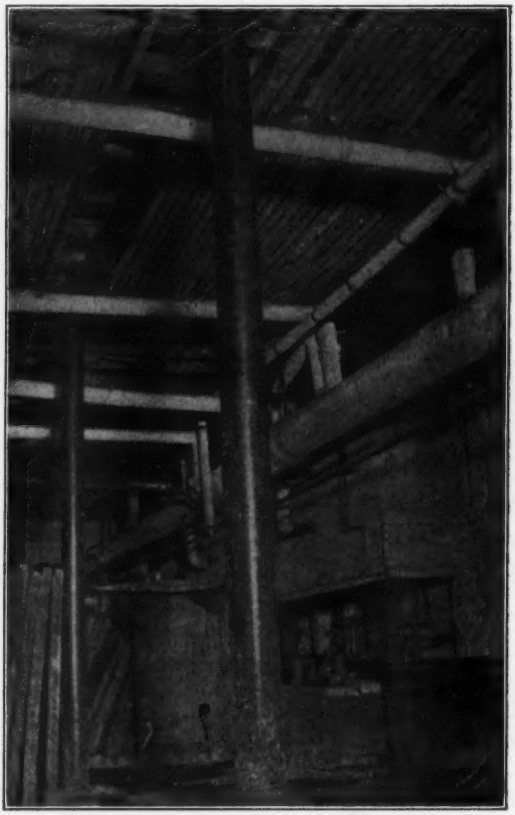


Fig. 19. The basement of a hospital for the insane. Note where plaster is missing, allowing a fire to spread quickly into joist channels. Wooden boxes around steam coils and combustible storage increase the fire hazard.

Dispensaries and Clinics.

These are usually comparatively small and are sometimes in hazardous locations. The patients are unfamiliar with their surroundings and need careful direction at time of fire. Nurses and doctors should thoroughly understand matters of sending in fire alarms, handling extinguishing equipment, and directing egress.

Hospitals and Asylums for Insane, Feeble-Minded, Defective, and Epileptic.

There are approximately 600 such institutions in the country. One of the chief difficulties is the provision of a sufficient force of attendants to handle inmates rapidly at time of fire. One attendant at least should be kept in each ward at all times, day and night. Where wards are large, there should be at least one attendant to every fifteen patients.

Many of those in charge of institutions for the insane claim that such persons are easier to control than those in possession of their normal faculties. This may ordinarily be true, but those who have had experience with insane in actual fires contend that they are more susceptible to panic than normal persons. In one instance, when the fire alarm sounded, patients hid under beds and in closets and fought those who endeavored to take them out.

Ordinarily no fire drills are held for insane patients, but several times each day they are assembled and marched in orderly manner to meals, to work, or to exercise. This gives excellent opportunity for drilling them in rapid exit and on such occasions the regular fire drill signal should be used and patients should be required to form and march out in as rapid and orderly a manner as would be necessary at time of fire. For drill purposes, patients should be assembled and marched out at irregular times of day. Night drills, while desirable, may not be feasible.

At many institutions for insane, there are work shops for raffia work, weaving, printing, mattress work, baking, shoe repairing, painting, carpentry, tailoring, etc. They all have their special fire hazards, and should never be located in main buildings occupied by inmates.

Insane patients have been known to jump from fire escapes with fatal results. Fire escapes, therefore, should preferably be enclosed by screens.

Sanatoriums for Drug Addicts, Alcoholics, Convalescents, and Tuberculars.

Inmates of such institutions are seldom helpless. They should be carefully instructed concerning fire alarms and egress at time of fire and should be frequently drilled.

Almshouses.

All too frequently such buildings are of old, combustible construction, in poor condition generally, with little or no attention given to fire protection. State, county, and local authorities should make frequent inspections, and should see that proper conditions are maintained. Inmates are often old and feeble and frequently nearly helpless. Fire drills should be held at frequent intervals and inmates should be trained to use every means of exit provided. Vertical outside ladders found on some institutions are worse than useless, ordinary fire escapes are dangerous, and the best means of egress from upper floors is by means of standard fire towers. Every effort should be made to house the inmates near the ground, and one story buildings are desirable.

Institutions for Blind.

The imaginations of blind persons are usually developed to a high degree, making them especially susceptible to panic. Fire alarm signals should be so arranged as to not unduly alarm the inmates. In many cases it is well if inmates do not know that fire has occurred. Competent leadership is absolutely essential. Fire drills should be held at frequent intervals and inmates should be trained to use every means of egress provided. Handrails on stairs should be continuous to the outside. Every effort should be made to house the inmates near the ground, preferably in one story buildings.

Institutions for Deaf and Dumb.

In such institutions, only hearing persons, namely teachers and other employees, can hear fire alarm gongs. It is therefore essential that the inmates never be beyond observation and control of teachers or attendants. Having sight, the inmates are not liable to panic except under actually dangerous conditions.

Fire drills should be held at frequent intervals. Signals should ordinarily be given by gongs and lights. At the sound of fire alarm, teachers or attendants should take control of inmates and march them out in orderly manner. The possibilities of fire drills at such institutions were demonstrated at a school for deaf children where all buildings were entirely emptied in forty-five seconds after sounding of the alarm.

Homes for the Aged.

Many of the inmates in such institutions are partially helpless. In some instances the mental faculties are seriously impaired. The main need is for an adequate number of competent attendants who should be frequently drilled in the proper handling of inmates at time of fire.

Orphan Asylums.

Here again the main need is for competent supervision. Fire drills should be held at least twice a month under strict discipline.

Homes for the Crippled.

As with other partially helpless persons, inmates of such institutions should be housed close to the ground, preferably in one story buildings. Fire drills should be frequently held, the strong being trained to assist the weak.

Summary of Needs.

For institutional buildings to be erected in the future, the following general provisions should be made:

1. Fire-resistive construction throughout.
2. Small fire areas.
3. Non-combustible furnishings as far as possible.
4. Adequate exits and alarm systems.
5. Automatic sprinklers for store rooms or other danger points.

For existing combustible buildings of frame or wood-joisted construction, the following should be provided:

1. A thorough detailed survey of the property by competent fire prevention engineers.
2. An arrangement of a logical program for improvement covering the most important matters first, and making each dollar spent provide maximum protection. Such a program will usually include:
   a—Elimination of possible causes of fire.
   b—Automatic sprinkler protection.
   c—Proper egress facilities.
   d—Enclosure of floor openings.
   e—Sub-division of large areas.
   f—Use of fire resistive construction for boiler rooms and other hazardous places.
   g—Detailed fire prevention work and frequent inspections.
   h—Frequent fire drills.
   i—Instruction of all employees in fire prevention, fire extinguishing, and sending of alarms.

Note: The writer gratefully acknowledges the statistical data secured through the National Board of Fire Underwriters and the permission to use a number of valuable photographs from the files of the National Automatic Sprinkler Association.

Alameda, California, Business District Conflagration.

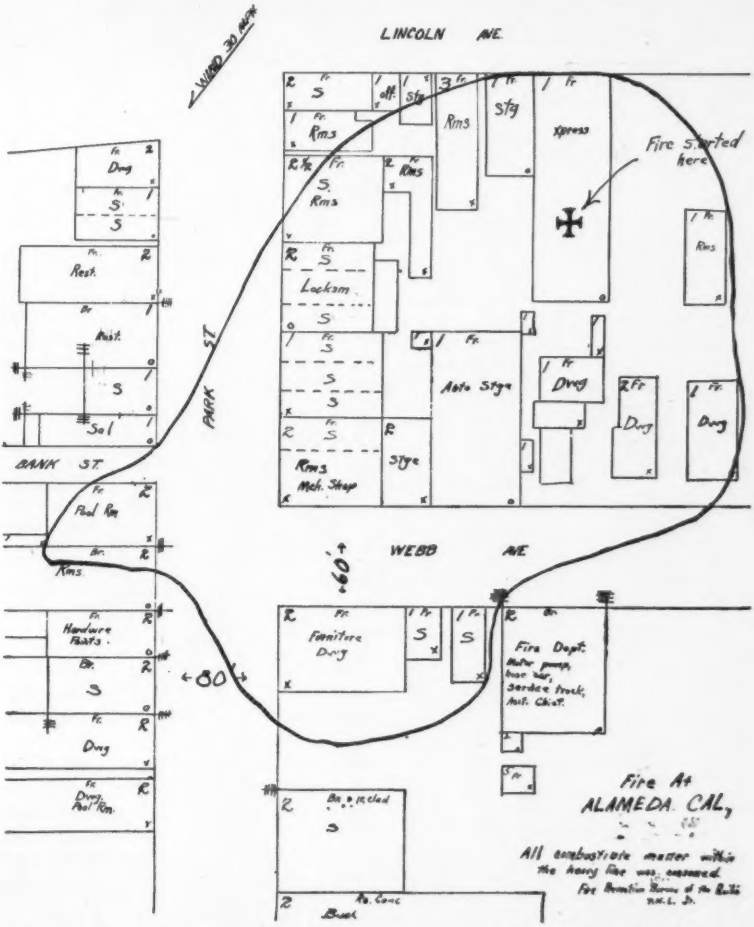
January 8, 1920.

Report and Photographs by Fire Prevention Bureau of the Pacific.
(Member N. F. P. A.)

With one exception, all the buildings involved were of one, two and three story frame construction with metal, shingle, and sheet composition roofs. The one exception was a two story ordinary joisted brick building. Most of the buildings destroyed were from thirty to forty years old, and were occupied principally by minor mercantile establishments. At least one-third of the stores were vacant. The block had always been recognized by the fire department as having conflagration possibilities and what happened was not unexpected.

Three blank brick walls in the direct path of the flames, a marked reduction in the velocity and a change in the direction of the wind, and additional fire streams made possible through outside help, were factors in the final halting of the conflagration.

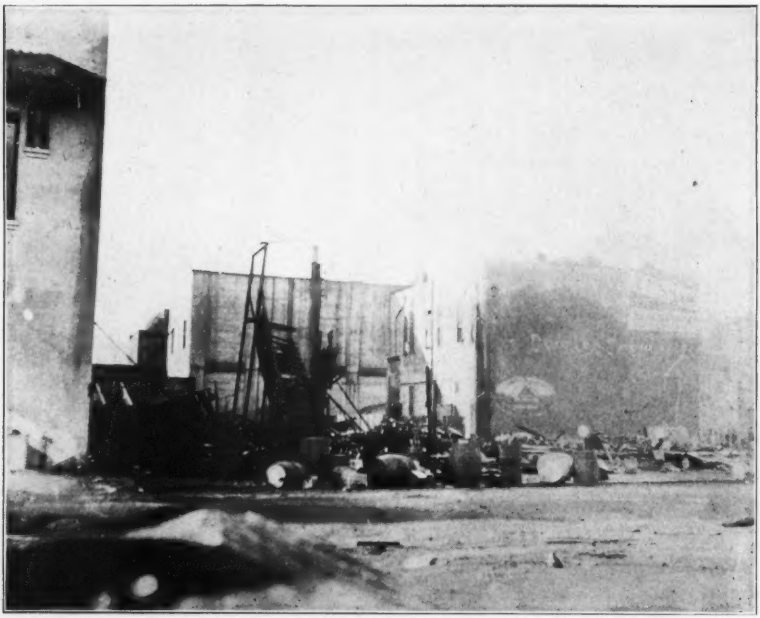
Ruins of Burned District, Alameda, Cal.—See plan on opposite page.



Alameda Conflagration, Jan. 8, 1920. Approximate scale, 1" = 95'.

The fire originated in the packing room of the Kellogg Express Co., located in the rear of No. 2418 Lincoln Ave. The cause is unknown. The first alarm was sounded from a street box at 2.44 P. M., followed by a general alarm at 2.47 P. M., and a call for help from Oakland and San Francisco at 2.50 P. M. The entire rear portion of the building in which the fire originated was a mass of flame when the fire department arrived.

Two days before the fire, a dredger working in the slough which separates the city of Alameda from Oakland on the north, shattered the sixteen inch water main which supplies the Alameda system, and the break being under water, repairs had not been completed when the fire occurred.



Where the Fire was stopped. Alameda, Cal., January 8, 1920.

There being only one other twelve inch main feeding the city system, hydrant pressure and water flow in the vicinity of the fire showed a marked reduction in its early stages.

In order to overcome the handicap of the broken main, gates on each side of the break were closed, and a motor pumping engine having 1200 gallons per minute capacity, was connected to a hydrant on the Oakland side of the slough, and two hose lines run over the draw bridge to a hydrant beyond the break on the Alameda side, a distance of 900 feet. An effective by-pass was thus created. This break in the main was about a mile from the fire.

The Alameda apparatus in service included one city service truck, four combination hose and chemical trucks, one Waterous pumper, and one Seagrave triple combination with booster pump. On receiving a telephone call for assistance from Walter T. Steinmetz, the Alameda chief, Chief Elliott Whitehead, of Oakland, responded, bringing with him two motor combination pump and hose wagons and a 1200 gallon pumper.

A private fire tug, as well as the San Francisco fire boat, answered calls for assistance, but were not used. Four railway switch engines, equipped with pumps and hose, did effective work on the Lincoln Ave. side of the fire.

Very shortly after start of the fire, the entire fire alarm system was put out of commission by the burning of the wires entering the central fire station.

Natick Box Company Fire.

Report by Underwriters' Bureau of New England, W. D. Milne Inspector.
(Member N. F. P. A.)

The fire which occurred in the unsprinklered property of the Natick Box Co., Natick, Mass., on January 7, 1920, is of interest on account of a building of so-called "fire-proof" construction having been involved, and also because it well illustrates the conditions which may arise in fires originating in buildings of even moderate size when the public facilities for protection are not ample.

Description of the Plant.

The accompanying diagram shows the arrangement of the buildings where the fire originated.

The plant was occupied for the usual processes for the manufacture of folding and other paper boxes, with incidental printing. Large stocks of paper and paper board were carried. The care of the property was generally good, but large quantities of light combustible material were necessarily present.

The manufacturing building was a four-story wooden, plank and timber structure about 60 feet x 90 feet, with lesser additions. Stairs and elevators were open. This structure connected at the first and second floors with the "storehouse" by means of a steel frame and wood pass-way, 15 feet long.

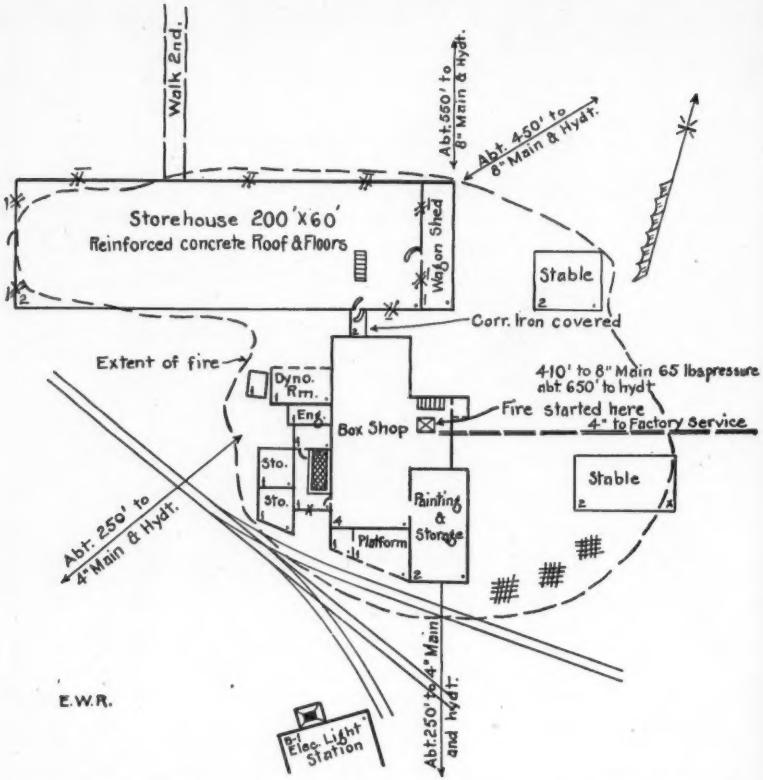
The storehouse was two stories, 200 feet x 60 feet, built in 1909. The frame (pilasters and columns), roof and floors were of heavy reinforced concrete, fairly well placed, and of apparently good design. The panels of the walls were filled between pilasters with 6 inch hollow tile, and there were few openings. Lack of means of access was an important factor in the loss, there being but few windows and these confined to the ends and part of one side.

At one end of the storehouse, and closely exposed by the manufacturing building, was a high, one story metal clad "lean-to" occupied as a wagon shed and containing considerable received material.

The occupancy of the storehouse was remarkable for the large and continuous piles of paper and paper board, not skidded.

Cut-Offs.

The manufacturing and storehouse buildings were nominally two separate fire areas. The openings to the pass-way connecting the two were protected by good, double, automatic tin-clad fire doors. With the exception of a possible opening around a steam pipe, the only other opening in the storehouse wall facing the frame buildings was one window opening



Natick Box Co. Plant. Approximate Scale, 1" = 80'.

in the second story. This was protected by a good wired glass window in a pressed steel sash, set into a shallow rabbet in the concrete.

The wagon shed at the end of the storehouse was closely exposed by the frame building but openings from it into the storehouse had wired glass in wood frames at windows, and tin clad swinging doors at doorways.

Protection.

There were no sprinklers in the factory, nor any other effective private protection. The public protection was weak on account of the distance to hydrants, as noted on diagram. The public fire department was on a part paid basis, with two steamers and one motor pump available. Street mains were under about 65 pounds pressure. Much of the piping was cement lined, laid 40 years or more ago.

The lack of men and equipment, and delay in getting into action,

usual faults in the ordinary small department, were important factors in this fire.

Story of the Fire.

Fire was discovered during noon hour by an employee returning from lunch. The cause was not definitely ascertained, but is supposed to have been smoking. The point of origin was in or near the open elevator shaft in the frame manufacturing building. The alarm was apparently sent promptly, but men on first apparatus to arrive found fire issuing from windows of all floors, evidence that the fire spread with great rapidity. The first lines of hose laid were 500 to 600 feet long, this causing delay. The heat from the frame building became so intense, that it is said that water was played on this building only for a minute or two. Apparently no water was applied to the tile wall of the storehouse exposed to the fire. Bursting hose, and the loss of one line of hose abandoned between the storehouse and stable further hampered the efforts of the department; and the wagon shed against the storehouse was soon involved. Both the exposed stables, lumber piles and freight cars at east and south were soon burning.

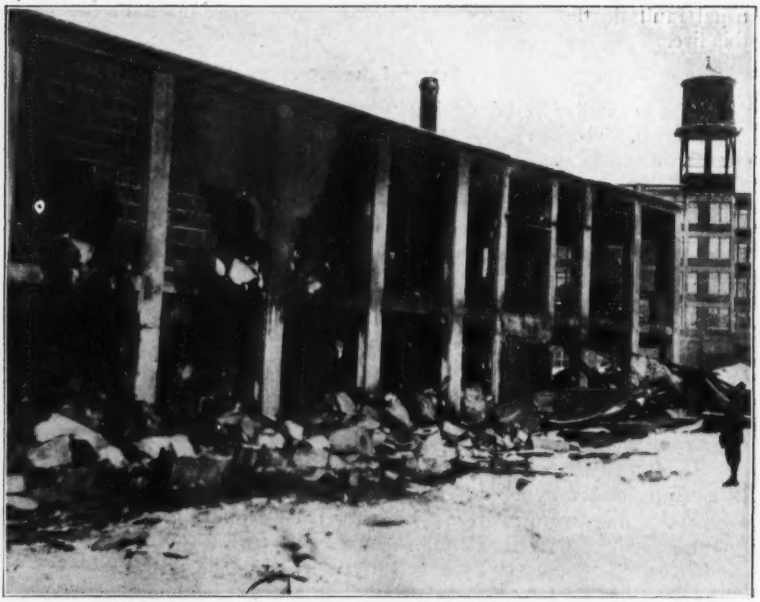
It is positively stated that all fire doors and windows in the storehouse were closed by employees early in the fire.

The frame manufacturing building collapsed, it is said, within 40 minutes of the start of the fire. Before this occurred other buildings had been involved in the fire, and for sometime after the collapse sheets of paper board from the piles in the building formed flaming brands which were carried by brisk wind eastward to the shingled roofs in the residential district. By these conditions, the activities of the firemen were called away from the main fire, and attention was given to preventing a conflagration. The public facilities were not equal to coping with both.

It is said that two hours elapsed before water was used inside the "fire-proof" storehouse, where fire had entered.

The appearance of the piles of material immediately inside the exposed wall of the storehouse indicates that sufficient heat was transmitted through the tile to cause ignition. The exposed wired glass window fell out of the wall, and the glass was apparently melted out of it. When the frame building collapsed, the pass-way in falling stripped the outer fire door at second floor from the storehouse wall and pushed the inner door ajar. The fire thus had ample opportunity to enter the storehouse on the directly exposed side, but the fire also destroyed the barrier between wagon shed and storehouse proper. This barrier consisted of a 6 inch hollow tile wall, with four small wired glass windows in wooden frames and non-automatic swinging tin clad fire doors.

When the firemen found opportunity to attack the fire in the storehouse, the fire had already travelled the greater part of the length of the building in the deep piles of combustible material, although the progress was relatively slow. There was but one entry to the storehouse, except on the side of the fire, and window openings were few. There were no scuppers. In order to get water on the deep piles of material, to let out smoke, and to relieve the floor of water load, the firemen punched holes through the tile walls and the roof.



Side of Natick Box Co. Storehouse — Concrete frame, 6" hollow tile panels.

The effort to entirely extinguish the fire in the storehouse continued until the afternoon of the day following the fire.

In all, seven public hose streams were used, all the hydrants indicated on the plan being utilized. Five hours after the start of the fire an 8 inch cement lined pipe on the city main broke and necessitated shutting off a portion of the main and relocating the pumping engines. The two steam fire engines ran about twelve hours each before giving out, while the motor pump operated 27 hours, except twenty minutes when being moved. The long lines of hose used called for high pressures, and it is said that a relatively large number of lengths of hose burst.

Effects of the Fire.

The frame manufacturing building was entirely destroyed.

The two nearby stables were practically destroyed; also two freight cars and some lumber at south.

The wagon shed was destroyed, and the entire tile work of the end wall of the storehouse toward it.

The tile work of a large part of the south wall of the storehouse was destroyed, while in other large sections of north and south wall, tile was broken out by firemen.

The reinforced concrete work of the storehouse was not perceptibly damaged by fire or water loading of floors, but roof was broken through by firemen in places.

The outer fire door at the second story of the pass-way was carried away and inner one burned out. The outer fire door at the first story of the pass-way was burned out, but the inner one held well.

The wooden sprinkler tank of shoe factory 300 feet east was slightly damaged by brands and the roofs of six or more dwellings in the residential district were damaged.

Interesting Features.

1. The open elevator shaft led to quick spread of fire.
2. The lack of nearby hydrants contributed to delay and interruption in fighting the fire.
3. The public fire department was not strong enough to at once attack the main fire and protect exposures.
4. The established opinion that 6 inch tile does not constitute an effective barrier for severe fire was further justified.
5. The tin clad fire doors did good service, but the fact that one was carried away by the falling pass-way showed that doors so located should be arranged to avoid possibility of their being stripped from their supports.
6. The failure of the wired glass window in steel sash showed the insufficiency of this form of protection, as against severe exposure, and also showed the need of fixing the sash securely in the wall by bolts.
7. The damage to the building done by firemen to reach the fire shows the desirability of means for access and ventilation where large quantities of combustible material are present.
8. The damage caused to paper by water showed the value of skids and scuppers. Large rolls of paper burst by the swelling action of the moisture, while vertical stacks of paper expanded greatly, expansion in a vertical pile 12 feet high amounting to 8 to 12 inches. Some such piles exerted great pressure on roof, and were so compressed that they had to be sawed out to remove them.
9. The danger of old cement-lined pipe was illustrated in this case by the failure of a pipe due to the vibration caused by the pumps.

In general the story of this fire shows the necessity for more fully realizing the severity of the attack which a fire may make upon physical barriers. It also shows the fallacy of relying on public facilities to establish a cut-off at an imperfect fire stop. In the erection of this property the cost of providing a standard cut-off would have been but slightly greater than what was actually spent to establish a barrier which proved valueless.

Gasoline Storage Tank Explosion.

Hays, Kansas, November 17, 1919.

Extract from Report Published in Bureau of Explosives Bulletin No. 46. Col. B. W. Dunn, Chief Inspector. (Member N. F. P. A.)

A serious feature of the explosion of gasoline storage tanks at Hays, Kan., Nov. 17, 1919, was the scattering of burning gasoline and oil on spectators and nearby buildings. Ten persons were thus killed and sixty injured. They were mainly part of a curious crowd which stood four hundred and fifty feet away from the tanks, watching the fire. Scores of others received minor injuries. In addition to the gasoline plant, seven dwellings, a grain elevator, and some railroad property were destroyed. The grain elevator was located on the railroad right-of-way. It suffered a loss of $42,792. The railroad's loss was $1,100, while the total estimated property loss amounted to $60,500.

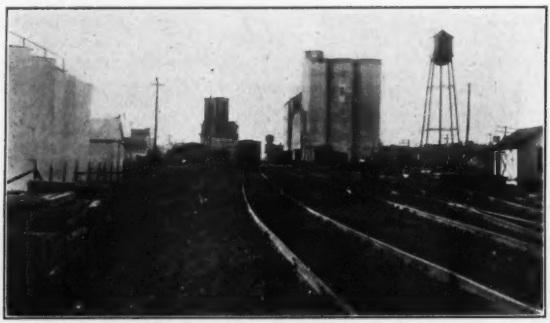


Fig. 1. General Location of the Explosion.

The fire started between seven and eight o'clock in the morning, when an employee of the oil company attempted to crank a Ford truck which had been stored in the supply house of the oil storage plant. The engine of the truck back-fired, and almost instantly the entire areaway was enveloped in flames, which rapidly spread to the storage tanks.

A general view of the location of the destroyed gasoline plant is shown in Fig. 1. It will be noted especially that the plant stood very near the railroad tracks. One corner of the plant was 33¼ feet and the other only 21 feet from the main line track. The five storage tanks were located about 28 feet from the sidetrack and 38¼ feet from the main line track. Storage tanks of other companies located on the railroad's right-of-way, and virtually along the main line roadway, can also be seen in this photograph.

The arrow in Fig. 2 points to one of the exploded storage tanks. This tank was hurled 620 feet from its original location. It traversed two

Fig. 2. One of the Tanks Landed 620 ft. from its Original Position.

Fig. 3. Ruins of the Plant.

streets and landed in the midst of dwellings. Two other tanks which exploded previously were thrown 120 and 180 feet, respectively, away from their former locations.

Fig. 3 shows the ruins of the gasoline storage plant, located on railroad property. It also shows two of the tanks whose contents burned quietly. These particular tanks had been perforated by bullets fired from a high powered rifle to prevent their explosion. If the safety valves had functioned properly this perforation would not have been necessary, and the explosion of other tanks would not have occurred.

This accident is a forcible illustration of the danger incident to the location of a hazardous industry near a railroad. For years the Bureau of Explosives has emphasized this danger, and recommended that new installations for handling gasoline be placed further away from the main line.

Their rules (B. C. L. 180) required that storage tanks containing from 500 to 48,000 gallons of gasoline be placed not less than 80 feet from a track over which engines are operated. For new tanks, not to exceed 18,000 gallons, the oil companies have agreed to fixing the minimum distance at 20 feet from a track over which passenger trains are operated. This compromised restriction now adopted (B. C. L. 190) is an improvement on the old practice of no restrictions, but it is evident that in dealing with individual cases safety requires that the greatest distance practicable be secured.

The Fire Hazard of Coated Fabric-Making.

By Chas. E. Worthington.
(Member N. F. P. A.)

The fire hazard of coated cloth manufacturing has always been a subject of interest, especially as regards the coating and drying processes. All of these factories, whether oilcloth, linoleum, mackintosh, carriage and automobile cloth, inner soling or the like, necessarily make free use of extremely combustible materials and volatile solvents. The processes are essentially similar and the hazards of manufacturing much the same.

For the volatile inflammable solvents there is no available substitute since whatever solvent is used must be completely neutral and incapable of forming any permanent chemical compound with any other material used and must be susceptible of complete elimination, leaving no trace of its former presence. The cost, moreover, must be within fixed limits. All of which conditions practically limit the solvent to benzine or benzol, with some use of acetone and alcohol in pyroxylin compounds; and more rarely carbon bisulphide and carbon tetrachloride.

In the appended list of 39 fires during the operation of drying, one may search vainly for any conclusive basis upon which to form a definite theory of hazard. In 13 instances the cause is frankly given by the investigators as "unknown," thus constituting exactly one-third of the entire number. Contact of stock with steam pipes is held responsible for six and the causes of the remainder, divided between static sparks and spontaneous ignition, are in the main avowedly conjectural.

In attempting to dispassionately review a collection of investigator's reports some allowance must be made for the usual desire on the part of the investigator to find some fairly plausible cause to which to attribute the fire origins. Possibilities are often adduced without very much reflection and often on incomplete circumstantial evidence.

Thus of the fires attributed to steam pipe contact there are but few cases in which the evidence is even convincingly circumstantial. "Stock was supposed to have fallen upon a hot pipe" fairly covers the majority. But even the theory of temporary contact with the steam pipe is not without a flaw. Rankin's computation places the temperature of steam with a pressure of 75 pounds per square inch at approximately 305 degrees F.—just a trifle more than is required to ignite a friction match held in contact. At 50 pounds pressure the pipe temperature would be about 280 degreees, which is not enough to ignite a friction match by contact. Under special conditions pipes at the higher pressure named could ignite wood, but only after continued contact and a considerable chemical and structural alteration in the wood itself from long exposure, a roundabout process in which the actual hot pipe is only an incidental, though necessary, factor.

Just what chemical changes occur in the stock, if any, that make it subject to self ignition at such comparatively low temperatures we do not know, but simply assume it as a fact in most cases as being the only plausible cause. This is true of the nine cases attributed to "spontaneous ignition of vapor." The general temperature of dry rooms is 200 degrees F. or less, since a higher temperature would injure the stock. There is no evidence that benzine vapors will ignite and explode at anywhere near this temperature, nor any clue as to the emission of other vapors or gases which would bring about self ignition.

The fires attributed to static sparks, eight in all, are even more hazy. When drawn over wooden frames, conceding the possibility of a frictional electric charge, the dry warm wood would be practically an insulator and a spark could pass only by means of a conducting substance coming within arcing distance. If on iron frames, the numerous and frequent contacts should serve to preserve an equality of electrification between cloth and frame, and the sparking would generally be from the frame to a conductor; unless, of course, in the event of a frame not grounded, the conductor should approach the fabric. The extent to which this attributed cause is speculative is indicated by the statement in one case that the weather was very hot and consequently favorable to electrical activity, and in another that very cold, clear weather favored electrical action.

The quantities of electrically sensitive gums in the coatings is small and of the remaining benzine still less, but allowing the electrification of these and the presence of a film of ignitable vapor above the stock the personal factor is to be considered.

Certain people at certain times are good conductors, the ability to light gas by sparks from a finger is not unusual, and many fully authenticated fires have originated from sparks to or from the human head or body. Should stock be drawn on the frames or handled by such a person and the stock be or become electrified a spark would inevitably follow the withdrawal (or in some cases the approach) of the hand, and thus in rare cases might be of sufficient intensity to produce a fire, although in the main the intensity would be too low to be noticeable. Some of these fires may have been caused in this way. This condition could hardly be discovered in advance and constitutes on the whole such a remote contingency that under ordinary conditions the adoption of the only preventives, rubber soles and gloves, seems practically useless.

Some of the 39 fires were undoubtedly due to common causes, and as to the remainder the conclusion seems inevitable that aside from those due to static sparks a special cause as yet undiscovered is in the main responsible. "Spontaneous combustion, *i. e.*, self-ignition from accumulated heat, could hardly occur in fabrics exposed to complete radiation and circulation of air, and in all of these cases of apparent self ignition there would seem to be a common unknown factor that is responsible. The problem is to find a way to uncover it. Nevertheless, frictional electricity must be accepted as the main hazard, and any remedy sought must be in better knowledge of its actual mode of action.

Drying Coated Fabrics.

S-590. This was a table oil cloth works, and the building in which the fire occurred was a 3-story brick structure, 115 feet by 26 feet, ceilings

partly boarded, wooden posts, wooden floors, with metal ventilator pipes, six inches in diameter, from the second floor to the roof. The building was used for drying muslin coated with clay, glue, etc., composition, live steam being used and the fabric hung in vertical loops from the ceiling. The drying temperature was 140°. It is believed that stock dropped on a steam pipe and so started the fire. The building was equipped with an old standard sprinkler system, with pendant heads and small supply pipes. At first the cloth obstructed the distribution of water from the sprinklers, but as it burned through and fell to the floor this condition was remedied. Ceilings and floors were burned considerably in places, but the sprinklers did good work and undoubtedly saved the building. The loss, including water damage, amounted to about $1,400.

H-1123. A 3-story, open joist, brick building was used on all floors for coating burlap in connection with the manufacture of oil cloth. The coating machines were located at the south end of each room, the remainder being used for racks on which the coated fabric was stretched horizontally to dry. There were five or six racks on a floor; these were composed of frames set 3 feet apart, each frame consisting of two side pieces of wood placed upright, with bars across, from top to bottom, placed about 5 inches apart. The fabric was stretched out across the bars and fastened at each end. Three of the racks had metal cross bars, but all the rest were constructed entirely of wood. The knives on the coating machines were grounded with copper wires to steam pipes. It was stated that the metal racks were grounded, and that no trouble had been experienced with the wooden racks. The coating used was a compound of linseed oil, naphtha and ochre. Sprinkler protection was being installed at the time of the fire, and it is believed that a lantern used by the pipers was responsible for the blaze. The coating machine was temporarily idle while the coating solution was being prepared for a new roll of fabric. Flames, which were first seen near where the pipers were working, spread with great rapidity through the stock on the racks. The building was practically gutted, the total loss being estimated at $26,000.

S-4275. Fire occurred on top floor of joisted building occupied as inlaid linoleum department. On this floor were four horizontal driers and one coating machine for coating "backing." The driers were racks 92 feet long, 7½ feet wide and 10½ feet high. Each drier was divided horizontally into forty sections by wire netting stretched from side to side. All the driers were heated by steam coils and pipes. At one end of the building was the coating machine, movable on tracks set at right angles to the ends of the driers. The cloth to be coated was run under the knife on the machine and then was drawn into one of the sections of a drying rack. A piece of cloth was being pulled into a rack about 30 feet from the end of the drier when its coating was ignited by a spark of static electricity generated by the friction of the cloth over the wire netting. The netting was supposed to be directly connected to the iron posts upon which it was supported, and these were grounded to a water pipe. The theory was advanced that the static spark was due to a defective contact at some point between the wire mesh and the iron posts. The damage by fire was small, but the water damage considerable. In all, the loss was about $10,500.

S-4746. Rubber carriage cloth was manufactured at this plant. The "heater" building was a single-story ordinary joisted structure, 35 feet by 70 feet, adjoining the main mill, with which it communicated through unprotected openings. The heater itself was in two sections, each about 25 feet long and 10 feet high; it was constructed of wood, tin-lined, and was steam heated by pipes on iron. It was not sprinklered, but was equipped with steam jet overhead. There were sprinklers in the building outside the heater, but the heater obstructed the distribution of water from them. There was considerable cloth in the heater at the time of the fire, but this is not thought to have had any connection with the blaze, which is attributed to overheated woodwork. The sprinkler system in the main building was of great value in preventing the fire from gaining much headway in that part of the plant. The damage amounted to $15,265.

S-6951. Drill, trunk burlap and duck cloth were coated with a compound of linseed oil, lampblack and naphtha thinner in the first story of a brick building with plank floor and open joisted ceiling. From the coating machine the fabric passed onto a traveling track in the dry room, where it hung in long folds directly over unprotected live steam coils located a few inches above the floor. The dry room temperature was about 175°. A tenter bar supporting the suspended cloth became misplaced, permitting cloth to come in contact with the steam pipe, and thus causing fire. Twelve sprinklers operated promptly, and the fire was extinguished with a loss of about $450.

S-10443-A. The stock in which fire occurred was burlap being dried after receiving a "backing" coat. The drier was of brick, plank construction, and was cut off from the rest of the plant by tin-clad fire doors and a blank wall. The material to be dried was hung in festoons, 30 to 40 feet long, supported at the top by iron pipes. The steam for heating was supplied from coils at the bottom, along the sides and on the concrete floor. No explanation of the fire can be given, as the point of origin was apparently at the top of the building, remote from the steam pipes. The property was protected by a standard sprinkler equipment, which held the fire in check, though the distribution of water was obstructed by the drying material. It was necessary also to play hose streams on the stock for many hours. The effect of the steam jets is also matter of interest. These were in operation through the entire duration of the fire, and it is claimed that they rendered valuable service in holding the blaze in check. They were arranged to discharge near the floor and operated on the festoons as they fell to the floor, where it was difficult to reach them with hose streams. The drier was being operated at full capacity at the time of the fire, and the whole of the stock was rendered useless. The building, however, suffered practically no damage. One or two columns were slightly charred, but not burned enough to necessitate replacement.

S-10678. The second floor of an old joisted building was occupied as a dry room for light coated cloth. The method of drying was to hang the material in festoons supported on wooden rods a few inches below the sprinkler heads at the ceiling. Heating to a temperature of about 150° was effected by steam pipes at the sides, on iron. The cause of the fire is supposed to have been either spontaneous combustion due to

oxidation in the coating of the cloth or the ignition of vapors given off by the coating when a piece of cloth broke and fell in a heap on the floor. Thirty-four sprinklers operated—a few on the floor above, into which heat from the fire spread through cracks in the floor—and were of great service in holding the blaze in check. As usual in such fires, the festoons interfered considerably with the distribution of water. The loss was slight.

H-9395. The building in which table oil cloth was coated and dried was of fire-resistive construction, and the dry room was protected with fire doors. The dry room had been filled with coated cloth and the fans installed for the purpose of exhausting the naphtha vapors generated during the process were working properly, when suddenly and without apparent cause an explosion occurred which blew the fire doors open and ignited the cloth. The fire doors were closed again and the fire, which burned fiercely for a short time, was fought with hose streams and chemical extinguishers. The blaze practically burned itself out for lack of fuel. Iron tracks inside the dry room were warped and the stock in the room was destroyed. Belting on the coating machine just outside the room was also burned.

S-18042. Table oil cloth was manufactured from heavy muslin cloth. The under side of the cloth was first sized with a starch preparation and dried. After this the material was coated and again dried, and lastly a coat of varnish was applied to it. The building in which the coating and drying were done was an old 4-story brick structure. Twenty-two feet at the west end of each floor were occupied by coating mills, the balance of the space being used as a dry room and separated from the coating room by a frame partition. The coating mixture contained benzine. The coated material was hung in festoons, about 8 feet high, the length of the dry room, or about 83 feet. The dry rooms were 10 feet in height, and a space of 10 inches was left between the bottom of the joists and the small sticks carrying the festoons. Steam pipes were located at sides of racks or rows of cloth and there were narrow aisles along sides of building and between every two rows of cloth. There was a line of pendant sprinklers over the centre of each row of cloth, these lines being 7 feet apart, and the sprinklers spaced 8 feet apart across the joists. The sprinklers were nippled off to one side of the pipes by short ½-inch nipples about 3 inches long, and were also raised a little to be more out of the way of the cloth. This threw the sprinklers slightly on an angle and somewhat interfered with the distribution of water, the heads being only about two inches below the bottom of the joists and six inches above the sticks carrying the festoons of cloth. All the sprinklers were 286° heads. In addition to the lines already mentioned, sprinklers were installed along the aisles at the side walls and two aisles in the centre of the building.

Half an hour before the fire the watchman examined the thermometers in the dry rooms on the various floors and reported a temperature of 150°. There was no sign of fire at that time, and the watchman found no festoons broken or fallen down. It is hardly probable, however, that every aisle on each floor is visited on the watchman's round, and there is therefore a possibility that cloth might have fallen in a heap on the floor

and ignited as a result of the oxidation of the coating. It should be noted that some newly varnished stock was also present, and that vapors from the oil used in mixing the varnish were always given off by stock drying after this treatment.

The fire rapidly got beyond control of the high test sprinklers, and there was some delay in summoning the fire department. The stock in the building was practically a total loss, and the third and fourth floors were entirely destroyed. Heavy damage was also done on the lower floors.

S-19013. A section of a drying room located between two of the buildings at a rubber works was partitioned off for use as a "heater" or drying room for cloth in rolls. The partitioned section measured 15 x 9 x 8 feet, and its wooden sides and top were lined with asbestos; it was not sprinklered. Live steam pipes were located at the floor with a wooden rack over them for holding the material to be dried. The cloth was dried during the night, the temperature ranging from 180° to 200°. There was an opening through a brick wall at the back of the drier, and the door here was kept open about 3 or 4 inches to permit air circulation. Although the watchman passed near the drier on his regular rounds, he noticed no sign of fire, but at 6.45 a. m. an employee on the floor above smelled smoke and notified him. An alarm was given, and on the arrival of the fire department a second alarm was turned in on account of the dense smoke which was now issuing from the drier. The additional apparatus was not, however, needed. One sprinkler outside the drier operated and was of service in preventing the spread of fire. The interior of the drier was practically destroyed with its contents, and it was necessary for the firemen to cut holes in the wall. Cloth stored in racks near to the door of the drier was also damaged. The total loss was between $2,600 and $2,800.

S-22353. Fire occurred in the drier box of a spreading machine used for coating cotton cloth with a pyroxylin plastic mixture, the product being known as artificial leather. The drier was of ⅞-inch wood suspended over the machine. The coated cloth passed from the machine through the drier, which contained two steam coils, and then wound on a reel. The drier was vented to the outer air by a galvanized ventilator, about 10 inches square, which extended through the wood-sheathed outside wall of the building in the first story. The ventilator extended vertically on the outside of the wall to a point just under a wood boxed cornice. The cause of the fire is believed to have been an electric spark igniting inflammable vapor in the drier. The drier was practically consumed, and flame passing up the ventilator scorched the boxed cornice and entered the hollow wall at the second floor. At this point it was checked by the fire department. Cloth or "leather" on the reel as well as in the drier was badly damaged.

On the morning of the day on which the fire occurred sprinklers had been installed in the drier, but had not been connected with the factory system. Had this connection been made the loss would undoubtedly have been very small.

S-23505. Rubber coated cloth was dried by steam in a wood metal-clad structure, 12 feet by 45 feet in area. The stock was arranged in festoons and heated by steam to about 250° F. An employee was

removing cloth from the drier when the contents suddenly burst into flame, causing three 286° sprinkler heads to operate. The doors of the drier were immediately closed and steam jets turned on. The fire was so quickly controlled that very little of the drier was even charred, but stock was damaged to the extent of about $600. It is believed that the fire was due to a static electric spark, which might have been avoided by effective grounding of the frame upon which the cloth was hung.

S-23891. Fire occurred in the top layer of 5-ply, close woven cotton belting, impregnated with rubber, which had been for thirty hours in a vacuum drying oven for the purpose of recovering the gasolene which had been used as a solvent for the rubber compound. The belting in which fire originated was on a steel car which had been withdrawn from the oven about two hours earlier. The belting was piled on the car in layers set up edgewise, alternate layers running lengthwise and crosswise, the top layer being crosswise. Only about one-third of the top layer was burned, the fire, which was of a smouldering character, being extinguished by the watchman with a hand chemical extinguisher. The cause of the fire is supposed to have been spontaneous heating.

S-24138. Rubberized cloth was overheated in a sprinklered frame interior dry oven, and fire ensued. Six sprinklers operated promptly and extinguished the fire without loss.

Drying Linoleum, Oil Cloth, Etc.

S-132. The cause of this fire is unknown. It started in a large room, 90 x 70 feet in area and 95 feet high, filled with painted linoleum hanging from the ceiling in loops. This room was separated only by a frame partition from the rest of the brick joisted building of which it formed part, and was not sprinklered. When fire spread into the rest of the building it had gained too much headway to be amenable to sprinkler control, especially where there were large quantities of oil cloth on flat racks which obstructed the distribution of water. Three buildings were totally destroyed with a loss of $200,000.

S-984. Fire occurred on the third floor of a brick joisted building used for coating and drying oil cloth. The cause was not definitely determined, but may have been a static electric spark. At the time of the fire cloth was being run into frame drying racks from the coating machine, and there were three or four large open tubs of mixed paint on the floor near the machine. The oil cloth was run flat into racks, one piece above another from floor to ceiling. There was a line of sprinklers over each rack and between the racks at the sides. The sprinkler system was of an old type, and the racks seriously obstructed the distribution of water. Nevertheless the equipment undoubtedly helped to save the building, although the roof and third story were completely destroyed. There was little damage to the building below the third story, but considerable water damage to stock.

H-150. Fire totally destroyed oil cloth and drying building, with a loss of about $70,000. The building was full of oil cloth hung in festoons. the steam pipes being all at the sides. The cause of the fire is unknown.

S-3541. There were five drying "cells" at each end of a brick oil cloth building. The dimensions of the cells were 70 x 14 feet, with a height of 60 feet; their construction consisted of brick walls, concrete floor and roof, with wood ventilators and heavy glass skylights. At the time of the fire varnished oil cloth was being passed from the varnish machine on the top floor of the oil cloth building horizontally over carrier rolls to the end of one of the cells, where the cloth was dried in festoons 45 feet deep. The varnish was 60 per cent. benzine, and undoubtedly the fire was caused by static electricity jumping from the varnished cloth to the ironwork of the carrier and igniting benzine vapors. The static charge on the cloth was due to friction when it was drawn by hand to the carrier, the weather being very cold and dry at the time. The standard fire doors at the openings to the cell were immediately closed and two sprinklers operated, extinguishing the fire with slight loss to the stock.

S-3542. The building in which fire occurred was a 3-story brick, light plank and timber structure, *i.e.*, 2-inch plank with 1-inch top flooring, on wood timbers mostly, supported by numerous light wood columns. Floors were apparently solid, tight and in good condition, and there were no openings in the dry rooms, except for blower pipes. Drying racks for linoleum extended 100 feet from the south end of the building on each floor, leaving an open space of 25 feet at the north end. The racks were constructed of wood vertical pieces, with crosspieces of iron upon which were laid iron strips running the length of the room. The linoleum was pushed or drawn over these strips. There were on each floor six racks, 7 to 9 feet wide, set in pairs, with passageways 3 feet wide between each pair. Racks reached from the floor to within 8 inches of the ceiling, and there were 40 channels, each 3 inches deep, to each rack. At time of fire racks were filled with linoleum-painted stock on the second and third and half the first floor; on the first floor there were also "backed" stock and several pieces of cork carpet.

The dry rooms were heated by blower and coils located in the basement at the south end of the building (one set for each floor) and by steam pipes at the side, using exhaust steam and live steam at 80 lbs. pressure.

Fire started, from unknown cause apparently, on the second floor, and burned through to first and third stories. It was discovered by watchman, and the fire department was at once summoned. For about an hour the fire did not break out of the building, though filling the latter with dense, suffocating smoke. By that time, however, the gravity tank supplies for the sprinkler system were exhausted and the fire began to burn furiously, destroying the entire third floor, with the exception of 25 feet at the north end. The destruction of the northern portion was prevented largely by the fire doors which were hung along the ends of the sections, used as dry rooms to confine the heat. These doors were 2½-inch wood, tin-clad, hung by wooden beams to the ceiling above, and although they were charred completely through in places, the tin coverings for the most part remained intact until the doors were broken down by the firemen after the blaze was under control.

There is some doubt whether the watchman visited the stations every hour on the night of the fire. The clock records indicate that he did not, but it was stated that, due to the heat and vapors in dry rooms, magnetos

in such locations often fail to register unless operated at unusual speed, and that the watchman was a reliable man. In any case, the fire had gained considerable headway before discovery, and as 286° sprinklers were used, although the temperature of the drier was not raised beyond 150°, there was delay in sprinkler operation. After the sprinklers opened they had to contend with very serious obstructions to water distribution, due to the racks of stock. The total loss was estimated at $40,000.

S-4156. The linoleum dry room occupied the east end of a 4-story brick joisted building, and extended from floor to roof. It was separated from the remainder of the building by a frame partition, tin-clad on the dry room side. Heating was by steam pipes at the sides and on the floor, the latter being covered with wooden slats to prevent linoleum from coming in contact with pipes in case a piece should fall from the rack. Twelve-foot widths of linoleum were manufactured here, cement from the adjoining cork building being pressed onto burlap on a calender, the product then being dried in festoons in the room already described. The stock was hung from iron pipes set closely in a rack about 3 feet above the level of the fourth floor of the building. The dry room was not sprinklered, but the rest of the room was equipped with 286° heads. Watchman discovered smoke issuing from windows of the dry room and turned in an alarm. About ten minutes after the discovery two employees ascended to the fourth floor of the building and opened the door in the frame partition which gave access to the dry room, the intention being to direct a hose stream over the top of the festoons of linoleum. When the door was opened a muffled explosion occurred, and a volume of soot or smoke poured out, driving the men from the fourth floor. A large number of sprinklers opened outside the dry room and rendered considerable service in checking the spread of the flames. The frame tin-clad partition withstood the fire better than could have been expected, but a great part of the roof was burned and parts of the walls badly damaged. About 30,000 yards of linoleum were either destroyed by fire or ruined by smoke and water.

It is believed that a piece of linoleum must have fallen and broken the wooden slats at the floor, or that such a fall occurred in a place where the slats were missing, and that contact with the pipes caused the material to ignite. The room does not seem to have been overheated, as the temperature shown at the time of the fire by a thermometer near the door was 154°. It is believed that the use of iron racks for the drying of printed linoleum which was carried on in the second, third and fourth stories was a factor in saving part of the building. Wooden racks would have furnished a large quantity of light and very dry material which might easily have ignited and caused much greater loss.

S-7383. No cause for this fire could be discovered. It occurred in a sprinklered room having brick walls, wood floor and open joisted ceiling, which was used for drying oil cloth on frame racks. Steam heating was used. Two sprinklers operated and controlled the fire, but owing to the congested condition of the dry room it could not immediately be ascertained how much headway the fire was making. Hose streams were therefore used in the room and on the floor above. The loss by fire was slight, but some water damage was incurred, the total loss being $700.

S-8094. Linoleum was dried in a single story brick building equal to four stories in height. The night watchman on his four o'clock round found that the drier was excessively warm, and opened the ventilators at the top. Shortly afterwards he noticed that something was wrong, and on investigation discovered that a fire was in progress near the top of the building. There was a narrow platform running around the drier near the top, and on this evidently the fire started. No definite cause can be assigned. The flames spread to the drying stock, which ignited at the top, allowing long burning pieces to fall to the floor. Sprinkler heads operated above the platform and held the fire in check, despite obstruction to distribution from the festooned cloth. Chemical extinguishers were used on the fallen stock after it had been removed from the dry room. Hose streams were also laid. Including smoke and water damage, the loss amounted to $3,000.

S-8302. A brick building 55 feet in height, with 2-inch plank roof on bay timbers, was used for drying linoleum, cork carpet and thinly calendered drill or cotton cloth known as "inner soling." The bays were 8 feet 3 inches, the timbers being formed of two 11 x 3¾-inch sticks with 2½-inch space between. The building was divided into two sections by a 12-inch wall, with 2-foot parapet. Just under the roof, however, this wall was reduced to 8 inches, and the bay timbers of the roof projected into the wall so that they almost met. Fire passed through the wall at this point.

Burlap, after being backed with paint and coated with cork composition to form linoleum, was festooned in the drier from iron pipes supported 47 feet above the floor by heavy wooden timbers, wooden columns extending to the ground in the center of the room, with some cross bracing. The drier was heated to a temperature of 150° by steam pipes at the floor and sides, these being protected in the former location by heavy wooden slats. Watchman noticed that the fumes given off by the composition on the linoleum were thicker and heavier than usual, and made a special examination to see that no material had fallen to the floor. A little later he made another visit to the room and opened a skylight for ventilation. A few minutes later he observed smoke pouring from the windows of the dry room. He turned in an alarm and went back into the building, in which no flame was yet visible, and was nearly suffocated in trying to shut off the steam. Most of the stock either fell or was pulled from the racks and formed piles on the floor. It was removed piece by piece, the pile blazing up each time a layer of cloth was lifted. The 286° sprinklers were somewhat slow in operating, but they were undoubtedly a factor in preventing the spread of the flames along the roof of the building. Practically all the stock in the section in which fire started was ruined, and some damage was done in the adjoining section when fire passed through the division wall as already noted. Other openings were efficiently protected by standard fire doors. The roof was considerably charred and skylight partly burned out. The heavy framework supporting the racks was also charred in one place.

There is some doubt as to which stock was first attacked by the fire, and no definite cause can be given. The fire started soon after 7 p. m., and was not finally under control until next morning. The loss was approximately $28,000.

H-4074. A brick joisted building 60 feet in height was used for drying backed and coated linoleum in long festoons. The precise cause

of the fire is unknown. Heating was by steam pipes well protected by frame guards. Although the building was divided into two sections, both were practically total losses. The area of the buildings was 11,250 square feet, and their capacity represented about 140,000 yards of linoleum. They were nearly full at the time of the fire, and there was no salvage on stock. The reason for the failure of the 21-inch brick division wall to confine the flames to the section of origin is to be found in the fact that it terminated 10 feet below the roof, being continued above this point by a frame metal-clad wall which was inadequate to resist the heat generated by the fire.

S-9068. Fire occurred in fire-resistive dry room in which linoleum 6 feet wide and ¼-inch thick was dried on horizontal racks of iron construction with 2 feet 4 inches clearance on either side. The linseed oil used in the compound with which the stock was coated was only 18 to 20 per cent. oxidized, and the stock was dried in the smallest of the drying rooms because of its hazardous character. It is supposed that spontaneous combustion was the cause of the blaze.

Sprinklers operated promptly and held fire in check, notwithstanding obstructions from the racks of stock. Eleven hose streams were used to extinguish the fire. The fire was well handled by the private fire department, and the building was not seriously damaged. There was, however, a loss of about $6,000 on stock and racks, the latter being badly warped.

S-11705. Fire occurred in one of a compact group of twelve driers of reinforced concrete construction. Each of these driers, sometimes known as "stoves" or "cells," was 100 feet long, 11 feet 6 inches wide and 58 feet high. The side walls were of reinforced concrete, 6 inches thick, strengthened at intervals of about 25 feet by heavy reinforced concrete piers or buttresses, 12 inches thick, 24 inches wide at the bottom, but tapering to a width of 12 inches at a point 48 feet above the floor. Roofs were formed of concrete slabs approximately 4 inches thick, and were supported on reinforced concrete beams and side walls. There were four monitors on each drier, these monitors being 24 feet long, 3 feet 10 inches wide and 6 feet high, and having walls of reinforced concrete, with wired glass in metal sash on one side only, so that the monitor windows from the same drier faced each other at a distance of 4 feet 3 inches. Each monitor had a round sheet-iron ventilator in the top.

Fifty feet above the concrete floor of each drier was a rack of 2-inch iron pipes to carry the linoleum, which hung in long festoons extending to a point 3 feet 8 inches from the floor. This rack was supported on reinforced concrete galleries 2 feet wide and 2 feet deep attached to the side walls. These galleries had a small opening in the floor through which a link belt passed and which was also designed to drain water from the gallery; they were reached by outside iron stairways, and the opening in each drier was protected by a fire door.

The stock was dark green cork carpet, which consisted of a burlap base coated with a composition containing ground cork, oxidized linseed oil, colors, and possibly some gums. The composition was about ¼-inch thick and was calendered onto the burlap.

The drier was heated by steam pipes at the sides and floor, all being on iron, and those at the floor directly under the stock on racks, with iron pipe guards, spaced 6 inches apart, 13 inches above the steam pipes. It is thought likely that a festoon of cork carpet fell on the pipe guards and

that the excessive heat ignited vapors given off by the coating. Another theory is that a fallen festoon might have toppled over into contact with steam pipes at the side, these not being protected.

Sprinklers operated promptly and kept the fire down, but not until hose streams had been directed upon the fire through the monitors was it possible to enter the drier through fire doors at the ground level and remove the stock. Owing to the cooling spray from the sprinklers, the structure was very little affected by the fire, but the heat was sufficient to warp and twist iron fixtures of the ventilators at the roof. Only about 20 per cent. of the stock in the drier was burned, and the remainder was ruined by heat and water.

S-12159. This fire occurred in the same drier as fire S-11705, reported above. Since the previous fire increased watchman service had been provided, but fire again occurred from a cause not definitely ascertained. If a festoon fell in this instance, it must have been very shortly before the fire, as watchman had made an examination half an hour previously and found everything in order. Although the drier was heated only to a temperature of about 115° F., it seems possible that spontaneous combustion may have occurred, due to rapid oxidation of material being dried. It was stated by the management, however, that in such cases a penetrating odor and smoke are given off long before the point of ignition is reached. Nothing of this sort was noticed on the night of the fire.

As in the earlier fire, the 212° sprinklers held the fire in check, and no damage of account was suffered by the building, but the loss on stock was considerable.

S-12908. The first floor of a 2-story-and-attic brick joisted building was used for coating oil cloth with a compound of linseed oil, lampblack and naphtha, and for drying the coated material by hanging it from rods in strips over live steam pipes supported on metal at the floor. The heating pipes were poorly protected by "dead" pipes, 6 inches apart, above. It is believed that a piece of cloth fell and came in contact with "live" piping. Sprinklers operated promptly, and watchman heard water flowing. Without investigation, he shut water off and later informed an employee of his action. The employee at once reopened the valve, but, due to the watchman's folly, the blaze, which apparently had been almost extinguished, rekindled, and burning through the ceiling, opened a large number of sprinklers in the second story, also gaining access to the attic and damaging the roof. In the first story, fire did not spread beyond the dry room, but above it did considerably more damage. Had the sprinklers not been interfered with, the loss would probably have been less than $100. Even under the adverse conditions mentioned, they were an important factor in checking the spread of the flames. The loss was $7,130.

S-13241. High grade printed linoleum was dried in this building. The paints used in printing the colors were mixed with linseed oil and red lead and litharge. Varnish and copal were mixed with the linseed oil after boiling, the varnish giving the desired lustre. The printing machine was located in the first story (height at this point equal to two stories) at the south end of a joisted four-story building; and printed linoleum was drawn up from the machine through 2½ x 7-feet trap doors in the floor, the openings being closed with slatted traps. The linoleum was

dried flat on iron racks, 90 feet long and 7 feet wide, on each floor. The construction of the racks was of round iron uprights, held in wooden strips along the ceiling, with iron rods between. The uprights were spaced 12 to 18 inches apart, and the cross rods 3 inches apart, forming spaces for 35 layers of linoleum in each story. There were three racks, one being double, so that there was only one aisle, 2 feet wide, between the racks [and an aisle at each side between the racks] and the side walls of the building. The driers were heated to 150° by steam pipes, on iron, at the sides; and they were partitioned off by frame partitions located 8 feet from the north end and 61 feet from the south end of the building, respectively.

Fire started on the fourth floor, where racks were nearly full in preparation for drying. An employee was locking the shutters when he noticed fire in the east rack, about halfway up. The flames were travelling rapidly to the ceiling. He immediately gave an alarm. Sprinklers operated and helped to confine the fire to the rack in which it originated, but the obstructions were too great to permit extinguishment except by hose streams. It was two hours before the blaze was finally extinguished. The contents of the east rack were almost entirely burned, and the stock in the other two racks also suffered severe water damage. There was also considerable water loss on the floors below. So effective were the sprinklers, where not obstructed, that the wooden strips holding the upright rods of the rack in which fire occurred were only slightly charred in one or two places.

None of the iron racks on which the printed linoleum was dried were grounded, as the stock moved very slowly a few feet at a time, and no benzine was used in mixing the colors. No trouble had previously been experienced from static electricity in this process, although the hazard was recognized and guarded against in other driers used for other material. The day of the fire was very hot, and it is possible that weather conditions were peculiarly favorable to the formation of a static spark, on the one hand, and of inflammable vapors from the coating on the other. Steam had not been turned into the steam pipes when fire occurred. The theory was also put forward that ignition occurred from a spark blown through an open window from the short stack from a forge in a smith shop located only about 20 feet east of the drier building.

S-13625. Burlap, after being painted on the back and dried, was coated with cork cement on calender rolls in an adjoining building and run into the drier. The drier was a one-equal-to-four-story building with stone and brick walls, open finish, slow-burning shingle roof, and large monitor skylights of thin glass; it contained three racks, formed of heavy timbers from the brick floor up, the supports for the cork carpet and linoleum being 3-inch iron pipes carried on steel beams on the wooden framework, 48 feet above the floor.

The cause of the fire is believed to have been spontaneous combustion in the cork cement, which contained wood pulp, gums and other ingredients. At times small quantities of this would fall from the edges of the carpet and accumulate in little piles on the floor or in the folds or bottom loops of festoons. Broken cement lying in this manner in the heat of the drier would begin to glow or smoulder and eventually burst into flame. Apparently this happened in one of the folds, and fire followed rapidly up the fold and burst out at the top of the rack. Sprinklers operated

promptly and held the fire partly in check. With the aid of a number of public and private hose streams the flames were gotten well under control in less than an hour.

The roof of the building was considerably damaged and the large monitor was practically burned off. The fire apparently started under the east end of the monitor and flames shot upward, breaking the thin glass sides. This probably served to draw fire away from the rest of the roof and from the west rack. The stock in the drier was practically a total loss, as what was not destroyed by fire was ruined by water.

S-13811. Fire occurred in a steam-heated brick drier building, with cement floor, one story equal to three. The cause is supposed to have been spontaneous ignition of the vapors given off by the drying linoleum. Watchman discovered fire on entering the room in the course of his rounds. He immediately turned on steam jets, and four hose streams were shortly afterwards brought into play. By this time 212° sprinklers and stream jets had operated so effectively that no flame was visible. A private hose stream was kept in readiness all night, after the city fire department had withdrawn, and at daybreak the debris was cleared away, steam being turned into the heating pipes by the following noon.

The damage to the building was slight, but about half the festooned linoleum was burned. Some of the remainder could be used again. The loss was estimated at $1,000.

S-13931. This fire occurred in the same drier, and practically under the same circumstances as fire S-13625 reported above. Since that fire special attention had been devoted to brushing small particles and loose pieces of mixture from the folds of the drying stock. Watchmen were instructed to do this on their hourly visits to the dry room. The coating was about ⅜-inch thick, and it had a tendency to shrink and curl during the first few hours after the material had been calendered and subjected to the heat of the drier. This condition was particularly noticeable on the night of the fire, and special inspections were made at frequent intervals under the supervision of the head watchman. Nevertheless fire occurred at about 5 a. m., watchmen being notified by sprinkler alarm. Sprinklers held the fire in check, but there was considerable loss on stock, and the roof and monitor again suffered damage.

S-18065. Spontaneous combustion was held responsible for fire in linoleum dry room. The building in which fire occurred was a one and three-story brick building having an area of 10,000 square feet, about one-half of which was occupied by two dry rooms divided by a broad, metal-clad partition, the drying and coating sections being separated by frame board doors. The drier in which fire started comprised a series of wooden racks from floor to roof, with a landing at each story level. It was heated by steam pipes safely arranged at the sides. Watchman discovered the fire very promptly, and the city fire department was immediately summoned. The smoke was very dense and at first was quite a hindrance to the firemen; nor was the fire completely extinguished for three hours. The sprinklers did most effective work, the condition of wooden racks located near the heart of the fire testifying to the important part they played in holding the blaze. Fortunately the drier was only a quarter filled, but the salvage upon the stock actually present was very small.

S-18554. An old frame-walled, light joisted building which had not been used for many months had just been re-occupied for drying purposes, and at the time of the fire contained stock of large value. Spontaneous ignition of drying oil cloth was apparently the cause of the blaze. Sprinklers operated, and the city fire department was promptly on the scene, but the interior of the building at its western end and practically all the roof were destroyed. The stock in the drying racks was practically a total loss.

S-19289. Fire occurred in a brick structure, one story equal to four in height, used for drying linoleum. Heating was by steam pipes along the floor, protected by wood slats. Possibly the steam pipes had not a proper clearance from this woodwork, but more probably a festoon of linoleum fell in a heap on the slats and was ignited. The drying stock was hung, in festoons of about 44 feet, from metal bars supported by timber stringers or beams running lengthwise the building at a distance of 6 feet from the roof, which was about 52 feet 6 inches above the floor.

The fire was burning with great intensity when discovered, and sprinklers and steam jets sufficed only to hold it in check. An attempt to use two private hose streams on the blaze was abandoned when it became clear that the water pressure on the sprinklers might be dangerously reduced thereby. It took the city fire department more than four hours to extinguish the fire.

The only damage to the building was the destruction of about half the roof, the stringers or beams supporting the racks not being sufficiently damaged to require removal. Fire doors kept the flames from spreading to adjoining buildings, but enough heat penetrated two steel curtain doors to cause fourteen sprinklers to operate on the further side with considerable water damage to stock there. The total loss amounted to $22,315.

S-19773. Machine printed linoleum was being drawn into drying racks constructed of metal and properly grounded. A flash was observed, at a point about 3 feet above the moving material, in stock that had been in the racks for some hours. The cause of the fire is supposed to have been static electricity. The blaze was extinguished with a loss of $1,322.

H-11764. The building in which explosion occurred consisted of a coating house, 32 x 100 feet in area, with a cut-off extension on the north measuring 32 x 32 feet, all one story. The walls were 8-inch brick on exposed steel frame, the south end being of corrugated iron on wood frame to allow for extension; the floor was concrete, the roof flat, 1-inch boards on steel purlins on steel trusses, slag covered. This coating house had three fire-resistive dry rooms on the east, each 10 feet 4 inches by 106 feet in area and about 15 feet high. On the west were seven similar rooms measuring 10 x 133 feet. All these dry rooms resembled long tubes abutting the head house, so that linoleum from the coating machine could be fed into them in festoons and be carried along by an endless chain system. At the west end of the seven dry rooms was a coating room 10 feet wide, cut off by heavy fire doors from each dry room or "stove." The dry rooms had concrete floors, 8-inch brick walls, not parapeted, and roofs of reinforced concrete. An eighth dry room was in course of construction on the north side of the seven just described.

The linoleum manufactured at this plant was made of burlap, or sometimes felt, coated with a mixture of boiled linseed oil, whiting and

ochre, thinned with naphtha. Each dry room was ventilated only by four sheet-iron pipes through the roof, the pipes being 12 inches in diameter, with no fans. Naphtha vapors from the drying stock, being heavier than air, did not escape through these ventilators, but formed an explosive mixture with the air near the floor. The rooms contained a few electric lights with vaporproof globes and wires in conduit; the heating was by steam coils safely arranged at the sides.

Possibly a nail in an employee's shoe struck a spark against the concrete floor, or possibly a discharge of static electricity occurred, due to a fault in the grounding of the machinery. Whatever the immediate cause, the explosive mixture in one of the dry rooms was ignited and a terrific explosion occurred, killing six men, seriously injuring several others, and inflicting heavy damage on the plant. Fire which followed was extinguished with comparatively small loss.

Spreading, Coating and Spot Proofing.

This record covers thirty-two fires. Twenty-seven of these originated in static sparks, nineteen in machines not effectively grounded, and eight in machines where the grounding was apparently adequate. Twenty-nine of the properties had sprinkler protection which either extinguished the fire or held it in check in twenty-four instances. In two cases (in one of which the fault was structural in building) the sprinklers failed totally and in three other cases "contributed materially to stopping the fire" but were not wholly satisfactory. This record as a whole is so good as to call for no special comment further than to emphasize the fact that good grounding offers a liberal measure of protection.

The efficiency of foam extinguishers in this class of fires is worthy of careful consideration. Their development has been so far largely experimental, but the result of experiments closely simulating the conditions of spreading and coating machine fires has proved very encouraging, actual experience so far tending to confirmation.

Spreading, Coating and Spot-Proofing Machine Fires.

S-1256. Fire occurred in coated cloth at coating machine on third floor of brick joisted building. The coating room occupied the full width of the building for a distance of 33 feet at the north end; it was separated by a wooden partition from the drier section, which extended also the width of the building, 92 feet southward. There were six wooden racks to the drier section, and sliding doors in the partition opened opposite to each, so that when cloth was being fed from the coating room, as was the case at the time of fire, there was plenty of opportunity for the flames to spread into the drier. The loss was about $14,500.

S-2784. A 4-story brick joisted building was used for printing, coating, and drying enamel oil cloth. A space extending 26 feet from the west end was occupied on each floor for printing and coating, while the balance was devoted to drying stock. The drying rooms had heavy wooden doors. On the second floor varnishing was in process, the cloth passing under wooden rollers, varnish being poured into the hollows thus formed and the excess scraped off by passing the stock under a steel knife. The varnish was composed of boiled linseed oil, cut with a small quantity of benzine. Fire was first seen coming from the machine near where the

cloth emerged. It travelled along the cloth into the drying room through an open door. The stock being varnished was "light cloth." Notwithstanding the fact that the varnish contained benzine, the knife was not grounded, although this precaution was taken in the case of machines used for coating "heavy cloth." It is believed that the fire was due to a static spark igniting benzine vapors. Old style pendant sprinklers, slightly canted to one side to make room for the operation of cloth carriers operated promptly in the drying room and seemed to be holding the fire in check, but when an attempt was made to use hose streams on the blaze, dense black smoke drove the employees back. The fire was finally extinguished with a loss of about $16,000.

S-2813. Either static electricity or a piece of grit or sand passing under the knife caused a spark which ignited vapors from paint containing benzine, with which burlap was coated. Fire was discovered just inside dry room in material coming from the coating machine to be dried on iron racks. Both coating knife and racks were well grounded. Automatic sprinklers and a hand controlled perforated pipe system were important factors in checking the spread of the flames. The fact that the racks were of metal and the ceiling iron-covered was another circumstance favoring speedy control of the blaze. The loss was not heavy.

S-3070. The coating machine was specially made for this plant. Mackintosh cloth, after being coated, ran over a series of steam coils and also a perforated pipe through which steam jets played for the purpose of preventing frictional electricity. It is believed that on the day of the fire stream was not turned into the perforated pipe, and consequently a flash fire occurred due to a static spark. The blaze was confined to the machine and was extinguished by sprinklers, hand hose, chemical extinguishers and a wet blanket. No claim was made.

S-3219. Carriage cloth being varnished at a coating mill caught in the machine and overturned it, emptying about 25 gallons of varnish onto the concrete floor. A spark, caused by either the frame of the mill or gears striking the concrete floor, ignited the varnish, and fire spread so rapidly that an automatic fire door closed immediately and almost imprisoned one of the employees in the varnishing room. Sprinklers operated promptly under heavy pressure from an automatic pump, and held fire out of dry rooms, the doors of which were open, and which contained a considerable quantity of festooned stock. The loss was less than $1,000.

S-3388. The top floor of a brick, joisted building was used for coating and drying carriage oil cloth. Fire is supposed to have been caused by static spark at ungrounded spreader blades of coating machine. Twelve sprinklers operated and held the fire in check. The employees did good work by throwing down the stock that was hanging in festoons. The fire worked its way, however, through two windows into a communicating building, where it spread into an attic and seriously damaged the roof. The loss was about $5,000.

S-4522. Cloth, being heavy and therefore sagging, was allowed to slide over part of the frame of the spreader machine near the knife and steam jet, but in such a manner that the steam could not strike the cloth. The entire frame of the machine consequently became charged with

electricity, and a static spark caused fire which flashed over the cloth. It was extinguished by six sprinklers with slight loss. Subsequently a wood roller was interposed between the head and foot roll of a machine so as to prevent cloth from sagging in the manner described.

S-5926. Fire was apparently caused by a static spark due to friction either as fabric passed under coating knife or as it was drawn from the coating machine into wooden drying racks. The coating knife was steel and apparently well grounded. The material coated was burlap and the coating mixture contained benzine. Sprinklers held the fire in check, and it was extinguished with a loss of about $2,000.

H-4019. This fire occurred at a "dope machine," which differs from the ordinary spreader in having no knife edge. In the dope machine, cloth runs over a roller revolving in the coating mixture which is in a trough. The rubber mixture in this instance contained a large amount of naphtha, vapor from which was ignited by a static spark. Steam jets were put in operation as soon as possible, but owing to employees' clothing igniting, there was some delay, and fire spread through a window in a brick wall behind the machine, igniting a churn for mixing rubber and gasoline. One hose stream and steam jets did good service in preventing fire from attacking other churns, in which case the whole building would probably have been destroyed. The dope machine was destroyed, together with a roll of cloth, and stock on an adjoining machine was badly damaged.

S-10035. Cotton fabric was being coated with a rubber cement compound, the solvents being benzol and naphtha. Fire occurred from a static spark at the rolls of the coating machine. The loss was $470. For the purpose of preventing future fires of the same character, a good system of grounds was provided.

S-10354. Silk goods coated with rubber were being run through a trough containing wax dissolved in naphtha at a spot-proofing machine. Thence it passed over steam coils. The trough of the machine contained about three gallons of naphtha, being fed by gravity from a tin tank of twelve gallons capacity about two feet above. Static electricity on the fabric caused a spark which set the naphtha on fire. The room was sprinklered, and the prompt operation of the sprinklers undoubtedly prevented the burning naphtha from igniting the building, which was of wooden construction. Chemical extinguishers were also used. Subsequently a perforated pipe and steam jet were installed under the cloth running through the machine. The loss was $686, chiefly damage by water which leaked through tinned floor to goods in story below.

S-10904. An iron rod placed on the fabric to keep it spread out before entering the spreader machine came in contact with the machine at the opening through which the fabric passed, causing friction which ignited the fabric. Ten sprinklers operated and held the fire in check, while the employees completed the extinguishment with sand and wet burlap. The fabric on the machine was destroyed, and water damaged the fabric on an adjoining machine. The cement in the tanks of these two machines was a total loss. There were six machines in the room, but the rest were not damaged.

S-11095. A static spark at a rubber spreading machine caused fire which instantly spread over the machine, badly burning two operatives and causing great heat and dense smoke. Thirteen sprinklers operated, but the water from these floated the burning coating mixture, which thus set fire to a nearby table and to insulation on electric wiring. As there was no fire door between the spreader room in which the blaze occurred and the one adjoining it, fire extended to the latter, causing three sprinklers to operate in this location. The principal damage was to balloon cloth and aëro cloth in process in the spreader rooms and to some compounds and stock which were damaged by a hose stream in the mixing room. The floors being amply drained, the water was quickly carried outside the building. The spreaders were not grounded.

S-11238. This was one of a series of small fires caused by static sparks igniting benzine vapors from cotton fabric coated with rubber cement. The method of operating the spreading machine was to run 20 to 25 feet of fabric through the cement tank and then allow this length to remain stationary over the drying pipes of the machine for about five minutes. In starting the machine after the drying process, static electricity was generated, due to the tendency of the cement to stick to the rolls of the machine. A metal hood was provided at the machine with flue ventilation through the roof, but the suction was insufficient to carry off all the vapor. Sprinklers operated and held the fire in the machine, but owing to the obstruction offered by the hood, the blaze had to be extinguished with hose streams and chemical extinguishers. The spreader was not well grounded. While the machine was in operation, it was customary to have a line of hose and a large chemical extinguisher available for immediate use.

S-12377. One of the series of fires mentioned in report on fire S-11238 above. The circumstances were in all respects similar, except that since the previous fire the rolls of the spreading machine had been grounded to water pipes. Apparently, however, the static electricity was not entirely disposed of by this means.

S-12788. Fire was first seen near the knife edge of a spreader machine on which cotton drill was coated for automobile tops. Two sprinklers operated, and with the aid of a chemical extinguisher and steam hose, the fire was soon extinguished. Water leaked through the floor into stories below and did some damage to stock. The spreader was grounded, and a wire collector back of the knife edge was also grounded on steam pipe. It was decided to provide a more direct and efficient ground to sprinkler piping over the machine. The loss was $1,000.

S-12821. An ordinary spreader fire, due to static spark. Although no claim resulted, it is of interest to note that sprinklers are stated to have spread the flames, which were extinguished with steam. Chapman neutralizers were subsequently installed both on the spreader and on the connecting power belts.

S-13746. The machine causing the fire was a simple knife-blade type used for coating duck or canvas with a compound of lampblack, linseed oil, rubber and clay, thinned with benzine. The knives were not securely grounded, and undoubtedly a static spark ignited vapors. There

was a sudden burst of flame which enveloped the machine and communicated to a festoon in the dry room. The employees barely had time to escape. Fifty-two sprinklers operated and held the fire in check, four private and three public hose streams were also used. The heaviest loss was from water passing through the floor and damaging stock below. In all the loss amounted to $4,570.

S-13959. Fire occurred as the result of a static spark while employee was using a hand knife to remove a small lump of cement from fabric which had passed the knife of a spreader machine. Two sprinklers and two lines of steam hose extinguished the blaze in about fifteen minutes. In pulling burning fabric from the machine, employees allowed this to come into contact with an adjoining machine, but fire did not spread beyond these two spreaders. Water ran down through floors below and caused some damage to storage in the basement. The loss was $1,096.

S-13974. This fire was in all respects similar to S-13746 above. On this occasion, however, a boy who was working at the coating machine lost his life. The property loss was about $5,000. No steps had been taken in the interval since the previous fire to remedy either the defective grounding of the machine or the poor arrangement which was responsible for the heavy water loss below in both cases.

S-13984. In this spreading machine cement was delivered on the cloth by gravity from a closed tank. The cloth was dried by being spirally wound on an open wheel of steel framework, about 20 feet in diameter. Fire started apparently from a static spark and flashed over the freshly spread cloth on the drying wheel, and over goods, cement and naphtha receptacles in the vicinity, but did not reach the closed tank. Sprinklers operated promptly and were effective in saving the building. 120 gallons of naphtha were burned, the total loss was $1,875.

S-14072. The building in which fire originated was a 3-story and basement, brick, joisted structure with a concealed space under the roof. On the second floor was located a spot-proofing machine, the trough of which was supplied with naphtha from a small tank nearby, which was connected with the trough by a pipe having a shut off valve. A static spark caused fire which spread rapidly through the room and to the floor above. Getting into the concealed space already mentioned, the flames practically destroyed the roof and the floor. Fire communicated to two other buildings doing heavy damage in one and necessitating the chopping away of roof sheathing in the other. The water loss was also considerable.

S-14138. The only point of interest about this spreader fire was the effectiveness of an asbestos blanket in extinguishing the blaze in the cement bath. The loss was $134.

S-14172. Rubberized cloth was cleaned of spots by placing rolls of about 60 yards under a spot-proofing machine. As the cloth unrolled, it passed under a roller immersed in a cleaning solution composed largely of naphtha, then over a series of rollers, first under, then over, a steam-heated coil, and was re-rolled on top. A static spark at the point of unrolling ignited naphtha fumes. The steam jet provided to prevent the

formation of static electricity was located at the "rolling up" end, too far away from the unrolling to be effective. The fire developed considerable heat but six sprinklers held it in check. Water from the sprinklers carried burning naphtha through a small hole in the floor, causing a little damage underneath.

S-15480. The advantages of an efficient ventilating system in connection with a spreader machine are well illustrated by this fire. The machine, which was heated by steam coils protected by screening, was covered by a heavy riveted galvanized iron hood, this hood connecting to an 8-inch pipe equipped with a fan and discharging outside. When a roll of cloth in the machine was destroyed by fire caused by a static electric sparks, the fan withdrew all flame, smoke and cinders from the room, and not enough heat escaped from the ventilating mechanism to open sprinklers above the hood. A 50-gallon can of naphtha-thinned mixture stood near the machine, but was not ignited.

S-18624. Artificial leather was made by coating cloth with a mixture of soluble cotton and alcohol. A long metal spreading and drying machine, so arranged as to condense the vapors with a view to recovery of the solvent, was in use when an explosion threw the top partly off and did such other damage as to put the machine permanently out of service. The explosion was not very severe, and employees in the room suffered no discomfort, although several windows were broken. Evidently a static electric spark was generated, notwithstanding the fact that the machine was grounded at each end; and the vapors were ignited by the spark. The fire loss outside the machine was slight, but water damage was considerable.

S-20003. An explosion which resulted in $3,000 damage occurred in a coating machine consisting of a wooden frame about 75 feet long and 5 feet wide, with steam pipes running its full length. The coating material was composed of nitrated cotton, castor oil, benzol and color pigments. It was applied at one end of the machine to cloth passing over a roll and under a knife edge. Coated cloth then passed over steam coils and was dried. These coils were enclosed in small galvanized iron and asbestos lined enclosures. The vapor from the coating material (consisting of benzol and water) passed over water-cooled coils and condensed, running through a metal pipe from the condensor to metal collecting tanks in an adjoining room. Subsequently the benzol was recovered for further use. Probably a static discharge of electricity from cloth which had just come over the roller ignited the benzol vapors in the machine. The slight fire which followed was easily extinguished.

H-12142. Building was a 2-story brick joisted structure having a concrete floor in the first story. An electric light above machines used for coating cloth with a preparation of amyl acetate, castor oil, nitrocellulose, etc., was held in position by a cord. The cord broke and allowed the light to fall. The bulb broke against the knife of the coating machine and the hot filament ignited inflammable vapors. Fire spread rapidly through the building. The loss was about $16,000.

H-12197. The knife of a coating machine used in the manufacture of artificial leather was not properly grounded. A static electric spark ignited inflammable vapors and the resulting loss was estimated to exceed $30,000.

S-20605. This fire was in the same plant as H-12197 above. After that fire the machines were grounded. A static spark, however, jumped to the cloth from the lower roll on a machine and started fire. The loss was small. As a further precaution it was decided to ground independently the knives and other parts of the machine.

S-20702. Rubber covered cloth was passed through a "stripe" machine, by which the rubbered side was dipped in gasoline and passed over rollers and steam pipes. Static electricity was generated at times and efforts to avoid this by grounding proved unsuccessful. On a cold, dry day gasoline in the tank of the machine ignited from a static discharge. One sprinkler operated and held the fire in check, but the actual extinguishment was effected by employees with wet rags taken from large tubs kept nearby for the purpose of smothering any fire that might occur in the tank.

S-20765. This fire was practically a repetition of S-18624 above. A large quantity of goods was stored in the same room with the spreading machine, and as a result of this, an unnecessarily heavy loss of $13,500 was incurred.

S-20808. Cloth was coated with a jelly composed of nitro-cellulose, mixed with a solvent containing benzol, acetone, alcohol and amyl acetate. The jelly was brought into the room in metal covered cans of 15 to 20 gallons capacity, which were suspended over the coating knife and roll. The coating machines were mounted on iron standards. After passing over the roll and under the knife, cloth was dried over horizontal steam pipes in the machines. The steam coils were enclosed, part of the enclosure being frame asbestos lined, and part copper and wired glass. Cold water flowed over the copper part and condensed the solvent vapors preparatory to recovery of the solvent. Humidifying apparatus was provided at the machine, consisting of a pan of water over steam coils, and all metal parts were well grounded to prevent static electrical discharges. A quick flash fire, which was almost an explosion, occurred at the feed end of the machine. Sprinklers and chemical extinguishers extinguished the blaze with slight loss. Examination after the fire showed that one of the ground wires was disconnected. It seems probable that vapors from the jelly were ignited by a static spark.

S-21055. In this instance a static electric spark caused fire at the opposite end of the machine from the spreader roll, the blaze being noticed between the end of the steam pipes and the wooden drum on to which the coated cloth passed after drying over the pipes. The steam jet with which the machine was equipped was located between the daub roll and the first coil of steam pipe. The machine was supposed to be grounded to the steam supply main, but there is reason for thinking that the ground wire was out of commission at the time of the fire. Sprinklers and live steam were used to extinguish the blaze.

S-21575. Heavy material had been saturated with rubber cement in another process and was being wound back over the spreader preparatory to spreading more rubber upon it. Four humidifier heads were installed in the room and these were in operation at the time of the fire. The spreader was provided with a ventilating device which carried away vapor from the drying fabric and also considerable air. Possibly air

passing into the room through open doors was drawn over the spreader before it could be humidified, and thus a static spark was formed which ignited the stock. As the material was being wound back, the steam jets behind the spreading knives were not in operation. The loss was about $100.

S-24625. A one-story building with concrete brick walls and wooden roof on joists, was occupied solely for spreader room. Spreading machine was of condenser type, drier being a part of machine and arranged to permit withdrawal of saturated air to condenser coils, the air being returned and reclaimed solvent stored for future use. The machine was grounded at both ends and also provided with steam jets at both ends. Covers at drier were arranged to lift and relieve in event of explosion. Coating material used a compound of ethyl acetate, benzol, denatured alcohol and nitro-cellulose. There were four men in room. A 500-yard roll had just been coated and the "runner" (which draws the web back when process is reversed) was about half way through. This runner was attached to the coated web by a metal clamp.

The first that was noticed was a flash at the north, or feed end, which ran the length of the machine. The explosion was practically simultaneous, raising the roof and blowing out and completely destroying a considerable part of walls. The machine in which the explosion occurred was completely wrecked and an adjacent machine badly damaged. Three of the men were seriously injured, the fourth slightly. Sprinkler equipment was completely put out of commission by the explosion, which was severe enough to inflict considerable damage in adjacent buildings, pipes were sheared and rotary gong, which was carried on the wrecked wall, was destroyed. Alarm was turned in by outsider and fire extinguished by three public and two private hose streams. Loss estimated at $25,000.

Origin of fire indeterminate, possibly static electricity or a spark from metal clamp passing over rolls. The real cause, however, was the attempt to combine solvent reclaiming apparatus with a machine normally producing a large volume of explosive vapor of solvents. The explosion hazard was recognized by the makers of the machine and what proved to be ineffective safeguards were provided.

Churns.

The record here given is partial and limited as to number, but taken in connection with a number of unlisted fires suggests that electrification of the churn may be as often responsible as the electrification of any portable container and its contents, and that sparks from the churn may as often be responsible as sparks to the churn. The fact that gasoline in the churn is subjected to violent agitation, and even mild agitation produces electrification of that material, affords support to this hypothesis.

Grounding the churn and gears would of course modify this condition, but tends to make the difference of electrification between any portable container and the churn greater and increase the intensity of the equalizing spark when passing from container to churn.

Possibly where it is impracticable to pump the gasoline into the churns by permanent iron pipes which will be always in contact it might prove practicable to provide a length of light chain attached to the churn at one

end and having a hook or snap at the other, making it easy to attach to a container. This apparently would not remove all danger but could be depended upon to considerably reduce the hazard.

In all cases the remarkable facility with which gasoline develops an electric charge if agitated appears to be a factor, and frequently the all-important one.

Sprinkler action in general has proved effective, but as might be expected, not wholly successful. Highly inflammable stock hanging in long loops or stretched in tiers on frames affords little opportunity for sprinkler action, and it must also be remembered that many of these drying rooms are very high and the amount of highly inflammable stock and the cubic contents of room per sprinkler disproportionately large, which is to say the sprinklers are given work beyond their capacity.

Twenty-nine fires are reported where the results of sprinkler protection are given. Five resulted in failure, eight in extinguishment or complete check by a small number of heads. In sixteen cases the sprinklers are reported to have been of material value "in checking the fire." Considering the inferior construction of many of the buildings, the obstruction to sprinkler operation by the stock and the great area of highly flammable surfaces, perhaps this is as much as could be expected. Whether sprinklers with larger orifices delivering a larger volume of water would prove effective is of course an open question, but there is a suggestion in the record that the delivery of the ordinary sprinkler is not commensurate with the intensity and rapidity of combustion. There is not enough data concerning the value of steam jets to justify any conclusions. Theoretically a sufficient volume of steam at a proper pressure should be completely effective as an extinguisher.

Churn Fires.

S-17758. One-story brick building, plank and timber roof. Occupancy solely churn room, mainly for compound for coating mackintosh goods. Plant in operation. Origin of fire static spark while pouring naphtha from can into churn. Sprinkler alarm (rotary gong) operated promptly. Two sprinklers opened, entirely extinguishing fire. Loss nominal.

S-11363. One-story brick building with plank and timber roof, occupancy churn and compound room. One churn was being filled by pouring in naphtha from can when "vapor was ignited, probably by sparks from adjacent machine." Twenty-five sprinklers opened but were quickly shut off and fire fought entirely by steam which was entirely successful. Loss nominal.

(In view of more extended experience in similar cases origin of igniting spark as given is open to question. Ed.)

S-19180. Building two-story, concrete block walls, framing part plank and timber, part joists. Locality churn room in basement working on rubber cement and mackintosh compound. Plant in operation. Fire in cement churn originating from spark caused by accidental contact of can containing naphtha with rim of churn.

Twenty sprinklers opened and practically extinguished fire, supplemented by one private hose stream and three 2½ gallon chemical extin-

guishers. Loss, confined to machine of origin and some belting and stock, $3,027. Two attendants were fatally burned in this fire.

S-11536. Building brick, joist construction. Churn room. Plant not in operation (night). Discovered by watchman. Churns were kept in operation all night and origin of fire "supposed to be spark from gears." Extinguished by one sprinkler directly over churn. Loss under $40.

S-23098. Two-story brick, plank and timber framing. Churn room, second story. Origin static electricity at hopper. Sprinklers operated and practically extinguished fire, although some final aid was given by hand hose and chemicals. Loss under $2,000.

S-24345. One-story brick building, concrete floor, plank and timber roof. Occupancy churn room. Origin from cause unknown, possibly spark in nearly empty churn. Extinguished by one chemical extinguisher. No sprinklers opened. Loss nominal.

H-12335. Building two-story frame, joisted. Occupied spreading, churn and compound rooms in first story. Night fire, not in operation. Watchman on round about two hours after closing down had just wound station in churn room and was about leaving room when he heard a snapping sound and looking back saw fire above one of the churns. Fire was brought under control in about an hour and a half by public fire department, using seven streams. Destruction of plant practically total. Insurance loss $15,000. No theory has been advanced to account for origin of fire, which, because of the large quantity of naphtha in the churns burned with much intensity.

H-13680. Building brick and concrete, ceiling concrete on exposed steel I beams. Location of fire, churn room. Fire in churn attributed to static electricity, spread to other churns and receptacles. Extinguished by three hose streams from near-by hydrants and 2½-gallon chemical extinguishers. Damage slight.

H-14680. Building brick, cement floor, metal roof. Cause of fire stated as "a flash in churn for mixing naphtha thinned waterproofing, undoubtedly caused by static electricity." No further particulars. Extinguished by steam jets and steam hose. Loss nominal. Fire confined to one churn.

H-6357. Building brick with metal clad joisted ceiling. In operation. Occupancy spreaders and churns. Fire originated about one of the churns from undetermined cause, reported as probably friction on bearings or static electricity. Fire fought by streams from yard hydrants and by public fire department. Burned for 1½ hours, and caused damage of $2,386.30.

H-8311. Building brick, tin-lined sides and ceiling, occupied for churns and spreaders, the processes being carried on in rooms separated by brick wall and automatic fire doors. Plant in operation. Battery consisted of eight churns. Fire originated in open churn in which employees were placing cut rubber, the churn containing at time some twenty gallons of naphtha, and flashed at once over all of the churns. Doors and windows were at once closed and fire fought with two-inch steam jet

under one hundred pounds pressure, and one yard stream. Duration of fire two hours. Was confined to churn room. Loss mainly on contents, not ascertained but moderate. One feature of this fire was the reported ineffective use of carbon tetrachloride extinguishers, and discomfort from suffocating fumes evolved by the tetrachloride. Cause of fire attributed to static electricity.

Miscellaneous Fires.

One fire, S-22063, calls for some special comment because of the conflicting theories of owner and investigator and the apparently untenable nature of both. The fact that the fire started in the tank would seem to preclude any spark in or from the machine, but there remains the probability of electricity generated by workman handling the cloth in the tank and a spark following his hand as it was withdrawn. Numerous fires are definitely established to have occurred in this manner, notably one in a golf ball factory in Massachusetts. Since benzine evaporates much more rapidly than tetrachloride the investigator's theory cannot stand. But the mixture was mechanical, not chemical, and segregation or settlement of the heavier carbon tetrachloride would be pretty sure to occur if a tub of the compound stood at rest for any considerable period. This would leave the benzine at the top. It is not improbable that this is exactly what occurred and ignition took place as suggested, by a spark following withdrawal of a hand. There is no precaution suggested other than that such mixtures be thoroughly stirred before using if they have been at rest for any considerable period, and that the stirring be done with a stick.

S-22063. Premises occupied for waterproofing fabrics. Location of fire third floor of three-story brick building, open joists. On this floor a roll of cloth was being cleaned by passing it through a bath of gasoline and carbon tetrachloride and then through rubber rolls to squeeze out the surplus liquid. Tank of liquid contained about five gallons. It was tested about one hour previous to fire by bringing a lighted match into close proximity without ignition. In some manner the liquid in the tank ignited during the process. It blazed up quickly and one sprinkler above the machine opened. An alarm was promptly given and the fire attacked by employees with water pails and extinguishers of the pyrene type, also carbon tetrachloride from an open barrel adjacent. Extinguished before arrival of fire department. Loss nominal. Process discontinued so far as this plant is concerned.

Owners attributed fire to static electricity in machine, a theory opposed by the fact that the fire broke out in the saturating tank containing cloth that had not been subject to machine friction. Another theory was that the carbon tetrachloride evaporated and left a mixture too rich in gasoline, but, as carbon tetrachloride is of about twice the specific gravity of gasoline and its evaporation correspondingly slow, this theory is not tenable.

S-5132. Fire occurred on premises of oil cloth factory. Building was brick, light open joist framing, first floor. Occupancy mixing room

for "backing compound" of oil, minerals and naphtha. There were numerous open tubs of this compound, which owing to naphtha content is highly inflammable. Employee states that while rolling a truck through this room at noon hour he heard a noise like a match snapping and immediately after discovered fire in one of the tubs. Cause attributed to truck going over match on floor, but no definite cause ascertained. Room was equipped with Grinnell glass disc sprinklers, five of which opened, blanketing the fire, which was later extinguished by mill fire brigade. Work of sprinklers very good. Woodwork was not ignited, although tub at first blazed fiercely.

H-13469. Artificial leather factory. Fire occurred in a detached one-story corrugated iron on wood frame building used for mixing a compound largely composed of picture films dissolved in alcohol. Works were shut down and fire was not discovered until the entire building was in flames. Total loss. No theory as to origin. Mill and public fire departments confined fire to building of origin. Reason for shutting down was hot weather. As buildings of this class become very warm it is quite possible that it was warm enough to decompose and ignite scrap celluloid left out of solution.

S-16643. Fire occurred in top floor of brick building used for manufacture of fire hose. At the time the fire occurred hose was passing through a box containing cement. The box has a cast iron nozzle through which the hose passes, losing its surplus cement. It was ignited at the point of leaving box, presumably by static electricity. Fire spread to a drum adjacent in which hose was wound and was extinguished by two sprinklers, one hose stream, some pails of sand and chemical extinguishers. Loss small, and much of that apparently due to needless use of water.

S-2092. This fire occurred on premises of an oil cloth and linoleum factory, the particular building being a four-story structure of ordinary open joist construction and brick walls; precise locality, drying room on fourth floor. Stock brought into room for drying was hung in laps on eight wooden racks, extending from floor to ceiling, racks extended whole length of room (about 80 feet). The coating apparatus was also on this floor. In the coating machines the coating material (naphtha thinned) was handled in the usual manner by putting it on upper surface of fabric before passing under the knives. Room contained six or seven barrels of the coating mixture in open tubs and some fifteen gallons of benzine (benzine was promptly removed). Fire was discovered in cloth on a rack while being drawn on rack from machine, origin attributed to friction. Room was equipped with 146 Grinnell glass disc sprinklers with a static pressure of about forty pounds, and also with a system (auxiliary) of three-inch perforated pipes operated by lever valves. These valves were promptly opened and apparently all the sprinklers fused, but the extreme combustibility and oily nature of the stock produced an uncontrollable fire, and it spread rapidly without appreciable check. Upper floor of building was pretty well gutted as to contents and structurally severely damaged. Fire finally extinguished by use of mill hose from yard with aid of city fire department. Investigators in commenting on this fire generally agree as to the inadvisability of locating such processes on

upper floors of buildings of light construction. They suggest that in all cases such work should be carried on in one-story fire-resistive buildings; that only iron racks should be used; that sprinkler equipment of exceptionally large pipes and high pressures should be provided; and that connecting perforated pipes to sprinkler supplies should be avoided. This was the third serious fire suffered in this room and process.

(The apparently needlessly excessive area of the dry room seems to have been an important factor, and in view of the highly successful use of steam in such fires suggests the utility of constructing such rooms in the smallest practical area and the use of steam jets preferably automatic. Ed.)

S-20903. Fire originated in a one-story brick structure with concrete floor and wooden roof, forming part of a cotton and rubber belting factory. Immediate origin in stock in or on large steam heated hydraulic press. This stock (belting) had previously been passed through a vacuum reclamation drier in which the major part of the naphtha was extracted and reclaimed. Coming from this drier, the thicker stock was put in the press and squeezed, the thinner stock laid on wooden racks above press subject to action of heat of press. Racks about 30 feet long and 5 feet wide. Steam pressure 65 pounds. Considerable quantity of stock in and on press at time of fire. Room of large area and well ventilated by monitor and windows. Cause of fire attributed by superintendent to static electricity generated by pulling a length of belting through press too rapidly. Inspector thinks it possible that some matter on top of press was ignited by heat. Building was equipped with Grinnell glass disc sprinklers of latest type, piped to 1905 standard, spaced about 7 feet x 7 feet 6 inches and staggered. Two supplies. Static pressure 45 pounds. 204 sprinklers in room. Seven heads opened and operated for about twenty-five minutes isolating the fire, but because of nature and distribution of stock failing to extinguish or fully control it until supplemented by the fire department. Loss nominal.

(Neither theory advanced for the fire seems adequate, but since all ventilation was from above level of machine and vapors of high specific gravity they may have been sufficiently dense under the machine to ignite from a spark struck in concrete floor and flash to stock, this is the most plausible origin. In these cases the flash is colorless and would attract no attention. Ed.)

S-11896. Not strictly a fire although reported as such. Belting factory. Stock in cast iron vacuum reclaiming dryer was found upon opening dryer to be almost entirely charred or carbonized. In this case a heat of 300 degrees or a trifle less was maintained with a twenty-three-inch vacuum. Time average per run twenty-four hours. Stock, canvas saturated with ordinary rubber compound with naphtha solvent was carried on steel cars. No apparently adequate theory has been advanced for the cause. That there was no fire is perhaps attributable to the limited supply of oxygen in a vacuum drier. No sprinklers opened. Loss on stock about $450. Other loss, none.

Annual Summary.

Statistics of Fires in Properties Having Automatic Sprinkler Protection.

NOTE.—These tabulations are made at the close of each fiscal year, with the object of furnishing a basis upon which the virtue of the automatic sprinkler as an extinguishing agent can be estimated.

Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.

Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.

In each table the results of the current year ending April 1, 1920, are given, and these are compared with the results of the total twenty-three year record ending at that time.

A decided increase in the number of sprinklered fire reports over last year is evident from the tabulation of the current year. The number of fires which were discovered and extinguished before there was sufficient heat to open the sprinklers increased from 376 to 712. This is an excellent testimonial to improved standards of housekeeping. The number of fires in which sprinklers operated increased from 1295 to 2021.

Of the sixty-four failures tabulated in Section I of the tables, eight were due to explosions wrecking the sprinkler system, and in seven cases the hazard of occupancy was too severe for the sprinkler equipment. Last year only one failure was attributed to explosion, and only two to severe hazard.

The sprinkler and supervisory alarm service makes a very good showing, of 176 fires the sprinkler alarm failed but once, and the supervisory twice.

SECTION I.

Summary of Unsatisfactory Sprinkler Fires.

	1919-1920		1897-1920, incl.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Water shut off sprinklers	23	36.0	283	27.9
Generally defective equipment	2	3.1		
Unsprinklered portions	5	7.8	224	22.0
Defective heads	1	1.6		
Defective water supply or supplies	5	7.8	93	9.1
Sprinkler system crippled due to freezing	2	3.1	36	3.5
Slow operation of dry system or defective valve	1	1.6	21	2.0
Slow or defective operation of high test heads	1	1.6	18	1.8
Faulty building construction, concealed spaces, vertical openings, etc.	3	4.7	46	4.5
Obstruction to distribution	1	1.6	60	5.9
Hazard of occupancy too severe for average sprinkler equipment	7	10.9	53	5.2
Explosion crippled sprinkler system	8	12.5	46	4.5
Exposure or conflagration	3	4.7	66	6.5
Miscellaneous	1	1.6	37	3.6
Plugged heads	..	..		
Not classified	1	1.6	34	3.3
Total	64		1017	

Special Classification of Fires in Which Failure was Due to Water Being Shut off Sprinklers.

	1919-1920. No. of Fires.	1897-1920. No. of Fires.
Water shut off for unknown reason, neglect or carelessness	5	107
Water shut off before fire was out or fire re-kindled	4	45
Water shut off due to accidents or repairs	6	48
Water shut off to prevent freezing	6	56
Water shut off, probably incendiary	1	4
Water shut off, leaky dry system	..	11
Water shut off, miscellaneous	1	10
Water shut off, defective gate valve	..	2
Total	23	283

SECTION II.

Annual Revision of Sprinkler Fire Tables.

In the following ten tables is given a summary of fires occurring in properties equipped with automatic sprinklers. The total number of such fires reported during the past year is 2733, which includes 712 fires where no sprinklers were opened. Several reports were also received in which the data was incomplete, and these were not used in the summary.

Table No. 1.

Time of Day.

	No. of Fires. 1919-1920.	No. of Fires. 1897-1920, incl.	Per Cent of No. with Data Given. 1919-1920.	Per Cent of No. with Data Given. 1897-1920, incl.
6 a. m. to 6 p. m.....	1118	12168	56.0	57.5
6 p. m. to 6 a. m.....	878	9010	44.0	42.5
Total with data given....	1996	21178		
No data	25	411		
Total	2021	21589		

Table No. 2.

How Discovered.

	No. of Fires. 1919-1920.	No. of Fires. 1897-1920, incl.	Per Cent of No. with Data Given. 1919-1920.	Per Cent of No. with Data Given. 1897-1920, incl.
Employee	1117	12489	57.5	59.4
Watchman	265	3146	13.5	15.0
Sprinkler Alarm	411	3381	20.8	16.1
Outsider	96	1064	4.9	5.1
Thermostats	28	674	1.4	3.2
Automatic Pump	..	11	..	..
Supervisory System	54	291	2.8	1.4
Total with data given....	1971	21056		
No data	50	533		
Total	2021	21589		

Table No. 3.

Efficiency of Alarm Service, 1919-1920.

Note.—This table does not include fires where alarm service does or does not operate promptly if fire is at once discovered by employees, the alarm service having no bearing on such fires one way or the other.

	Satisfactory.		Failure.		Total.
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	
Watchman alone	147	92.4	12	7.6	159
Sprinkler Alarm alone	138	96.0	6	4.0	144
Thermostats alone	2	100.0	..	..	2
Supervisory System alone....	7	100.0	..	..	7

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	105	79*	170	14	..	..	..	..	184
Watchman and Thermostats	..	..	..	..	..	..	..	..	..
Sprinkler Alarm and Thermostats	..	..	14	..	11	3	..	..	14
Watchman, Sprinkler Alarm and Thermostats	4	3*	6	1	6	1	..	..	7
Sprinkler Alarm and Supervisory	..	..	175	1	..	..	174	2	176
Watchman and Supervisory	4	..	..	..	..	..	4	..	4
Watchman, Sprinkler Alarm and Supervisory	13	45*	56	2	..	..	55	3	58
Sprinkler Alarm, Thermostats and Supervisory	..	..	21	1	17	5	22	..	22

Efficiency of Alarm Service, 1897-1920, Inclusive.

	Satisfactory.		Failure.		
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	Total.
Watchman Alone	1812	89.8	206	10.2	2018
Sprinkler Alarm Alone	1989	93.9	129	6.1	2118
Thermostats Alone	186	79.5	48	20.5	234

	Watchman		Sprinker Alarm		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	1302	896*	1949	249	..	..	..	..	2198
Watchman and Thermostats	19	8*	..	..	25	2	..	..	27
Sprinkler Alarm and Thermostats	..	..	504	40	419	125	..	..	544
Watchman, Sprinkler Alarm and Thermostats	45	74*	110	9	90	29	..	..	119
Sprinkler Alarm and Supervisory	..	..	423	11	..	..	427	7	434
Watchman and Supervisory	10	9*	..	..	..	..	19	..	19
Watchman, Sprinkler Alarm and Supervisory	80	156*	226	10	..	..	227	9	236
Sprinkler Alarm, Thermostats and Supervisory	..	..	59	2	49	12	61	..	61

* These include fires where sprinkler alarm or thermostat notified the watchman.

Table No. 4.

Number of Sprinklers Operating.

No. of Sprinklers Operating.	No. of Fires. 1919-1920.	No. of Fires. 1897-1920, incl.	Per Cent. of No. with Data Given. 1919-1920.	Per Cent. of No. with Data Given. 1897-1920, incl.
1	695	7342	35.2	32.1
2	380	3819	19.2	16.8
3	164	2278	8.3	10.0
4	131	1661	6.6	7.3
5	89	1056	4.5	4.6
6	69	900	3.5	3.9
7	57	599	2.9	2.6
8	45	564	2.3	2.5
9	30	386	1.5	1.7
10	28	345	1.4	1.5
11	15	279	.8	1.2
12	24	326	1.2	1.4
13	15	189	.8	.8
14	19	212	1.0	.9
15	18	175	1.1	.8
16 to 20	54	607	2.7	2.7
21 to 25	23	387	1.2	1.7
26 to 30	19	274	1.0	1.2
31 to 35	16	175	.8	.8
36 to 40	11	151	.6	.7
41 to 50	26	210	1.3	.9
51 to 75	21	280	1.1	1.2
76 to 100	8	125	.2	.5
Over 100	19	477	1.0	2.1
Total with data given	1976	22817		
Water shut off sprinklers	23	249		
No data	22	347		
Total	2021	23413		

Table No. 5.

Number of Sprinklers Operating.

No. of Sprinklers Operating.	No. of Fires. 1897-1920, incl.	Per Cent of No. with Data Given. 1897-1920, incl.
1	7342	32.2
2 or less	11161	48.9
3 or less	13439	58.9
4 or less	15100	66.2
5 or less	16156	70.8
6 or less	17056	74.7
7 or less	17655	77.3
8 or less	18219	79.8
9 or less	18605	81.5
10 or less	18950	83.0
11 or less	19229	84.2

Table No. 5 — Continued.

No. of Sprinklers Operating.	No. of Fires 1897-1920, incl.	Per Cent of No. with Data Given. 1897-1920, incl.
12 or less	19555	85.6
13 or less	19744	86.4
14 or less	19956	87.3
15 or less	20131	88.1
20 or less	20738	90.8
25 or less	21125	92.5
30 or less	21399	93.7
35 or less	21574	94.5
40 or less	21725	95.2
50 or less	21935	96.1
75 or less	22215	97.3
100 or less	22340	97.9
Over 100	477	2.1
Total with data given	22817	
Water shut off sprinklers	249	
No data	347	
Total	23413	

Table No. 6.

Sprinklers Opened on Wet or Dry Systems.

	No. of Fires. 1919-1920.	No. of Fires. 1897-1920, incl.	Per Cent. of No. with Data Given. 1919-1920.	Per Cent. of No. with Data Given. 1897-1920, incl.
Wet System	1659	17084	83.5	81.4
Dry System	328	3910	16.5	18.6
Total with data given	1987	20994		
Water shut off system	23	249		
No data	11	346		
Total	2021	21589		

Table No. 7.

Primary Water Supplies to Sprinklers Opened.

	No. of Fires. 1919-1920.	No. of Fires. 1897-1920, incl.	Per Cent. of No. with Data Given. 1919-1920.	Per Cent. of No. with Data Given. 1897-1920, incl.
Waterworks	1120	10975	57.6	52.9
Gravity Tank	357	5383	18.4	25.8
Pressure Tank	361	3368	18.6	16.1
Automatic Steam Pump	93	1115	4.8	5.4
Automatic Electric Pump	14	33	.7	.2
Steamer Connection	..	3	..	.02
Total with data given	1945	20877		
Water shut off system	23	249		
No data	53	473		
Total	2021	21589		

Table No. 8.

Effect of Sprinklers.

	No. of Fires. 1919-1920.	No. of Fires. 1897-1920, incl.	Per Cent. of Whole. 1919-1920.	Per Cent. of Whole. 1897-1920, incl.
Practically or entirely extinguished	1309	15291	64.72	65.33
Held fire in check	648	7105	32.12	30.33
	1957	22396	96.84	95.66
Unsatisfactory	64	1017	3.16	4.34
Total	2021	23413		

Table No. 9

Showing Effect of Sprinklers by Class of Occupancy.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Agricultural Implements	49	57.0	33	38.3	82	95.3	4	4.7	86
Alcohol (Wood) Plant	..	....	1	100.0	1	100.0	..	..	1
Automobile and Bicycle Factories	83	59.7	50	36.0	133	95.7	6	4.3	139
Awning Factories	5	83.3	1	16.7	6	100.0	..	..	6
Bag Factories	6	54.5	5	45.5	11	100.0	..	..	11
Bakeries	49	71.0	18	26.1	67	97.1	2	2.9	69
Basket Factories	7	87.5	1	12.5	8	100.0	..	..	8
Bolt, Nut and Screw Works	16	72.7	6	27.3	22	100.0	..	..	22
Boot and Shoe Shops	443	73.2	140	23.1	583	96.3	23	3.7	606
Bottling Works	4	100.0	..	....	4	100.0	..	..	4
Braiding Mills	8	80.0	2	20.0	10	100.0	..	..	10
Breweries	5	83.4	1	16.6	6	100.0	..	..	6
Broom Factories	9	60.0	4	26.6	13	86.6	2	13.4	15
Brush Factories	16	80.0	4	20.0	20	100.0	..	..	20
Button Manufactories	28	80.0	6	17.1	34	97.1	1	2.9	35
Candle Factories	4	44.4	5	55.6	9	100.0	..	..	9
Candy Factories	80	72.0	30	27.0	110	99.0	1	1.0	111
Canning Works	9	69.2	3	23.1	12	92.3	1	7.7	13
Car Houses	24	47.0	21	41.2	45	88.2	6	11.8	51
Car Works	59	60.0	37	37.0	96	97.0	3	3.0	99
Carpet Mills	144	61.3	82	34.9	226	96.2	9	3.8	235
Carriage Factories	95	66.5	39	27.2	134	93.7	9	6.3	143
Celluloid (Pyroxylin Plastic)	112	69.2	30	18.5	142	87.7	20	12.3	162
Cement and Plaster Works	2	66.7	..	....	2	66.7	1	33.3	3
Cereal Mills	30	66.7	10	22.2	40	88.9	5	11.1	45
Chemical and White Lead	61	54.5	42	37.5	103	92.0	9	8.0	112
Clothing Factories	567	81.2	123	17.6	690	98.8	8	1.2	698
Coffee and Spice Mills	39	68.4	16	28.1	55	96.5	2	3.5	57
Coffin Factories	40	78.4	10	19.6	50	98.0	1	2.0	51
Cold Storage Plants	4	50.0	4	50.0	8	100.0	..	..	8
Cooperage Plants	45	55.6	27	33.3	72	88.9	9	11.1	81
Cordage Works	190	65.5	89	30.7	279	96.2	11	3.8	290
Cork Factories	11	52.4	8	38.1	19	90.5	2	9.5	21
Corset Factories	6	60.0	3	30.0	9	90.0	1	10.0	10
Cotton Ginnery	10	66.7	5	33.3	15	100.0	..	..	15
Cotton Mills	3494	62.0	2079	36.9	5573	98.9	63	1.1	5636
Cotton Warehouses	108	46.4	103	44.2	211	90.6	22	9.4	233
Cotton Seed Oil Mills	37	52.1	23	32.4	60	84.5	11	15.5	71
Cutlery and Tools	18	64.3	9	32.1	27	96.4	1	3.6	28

Table No. 9 — Continued.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Department Stores	328	80.0	71	17.3	399	97.3	11	2.7	410
Distilleries	8	80.0	2	20.0	10	100.0	..	..	10
Drug Houses	136	79.5	31	18.1	167	97.6	4	2.4	171
Dry Cleaning Establishments	5	83.3	1	16.7	6	100.0	..	..	6
Dyeing, Bleaching and Finishing	123	52.3	101	43.0	224	95.3	11	4.7	235
Electrical Appliances	130	74.8	39	22.4	169	97.2	5	2.8	174
Electric Light and Power Plants	2	22.2	5	55.6	7	77.8	2	22.2	9
Elevators, Grain	24	36.9	25	38.4	49	75.3	16	24.7	65
Excelsior Factories	22	78.6	5	17.8	27	96.4	1	3.6	28
Fertilizer Plants	19	61.3	9	29.0	28	90.3	3	9.7	31
Flax and Linen Mills	20	46.5	23	53.5	43	100.0	..	..	43
Flour and Grist Mills	50	57.5	29	33.3	79	90.8	8	9.2	87
Forge and Smithy	47	58.0	27	33.4	74	91.4	7	8.6	81
Foundries	122	57.0	83	38.8	205	95.8	9	4.2	214
Furniture Factories	421	64.3	180	27.5	601	91.8	54	8.2	655
Garages	83	67.5	36	29.3	119	96.8	4	3.2	123
Garbage Reduction Plants	3	60.0	1	20.0	4	80.0	1	20.0	5
Gas Plants	2	66.7	1	33.3	3	100.0	..	..	3
Glass Works	46	57.5	27	33.8	73	91.3	7	8.7	80
Glove Factories	8	80.0	2	20.0	10	100.0	..	..	10
Glue Factories	5	45.5	4	36.4	9	81.9	2	18.1	11
Groceries	53	80.3	9	13.6	62	93.9	4	6.1	66
Harness and Fancy Leather	69	80.2	17	19.7	86	100.0	..	..	86
Hat, Fur	55	73.3	15	20.0	70	93.3	5	6.7	75
Hat, Straw	25	67.5	12	32.5	37	100.0	..	..	37
Hatters' Fur Mfg	9	56.2	6	37.5	15	93.7	1	6.3	16
Ice Plants	2	100.0	..	....	2	100.0	..	..	2
Incandescent Lamp Factories	13	61.9	8	38.1	21	100.0	..	..	21
Insulated Wire Factories	26	66.7	13	33.3	39	100.0	..	..	39
Jewelry Shops	108	89.3	9	7.4	117	96.7	4	3.3	121
Junk Shops	13	86.6	1	6.7	14	93.3	1	6.7	15
Knitting Mills, Cop Yarn	39	60.9	19	29.7	58	90.6	6	9.4	64
Knitting Mills, Full Process	436	64.2	221	32.5	657	96.7	23	3.3	680
Laundries	40	71.5	14	25.0	54	96.5	2	3.5	56
Lead Pencil Factories	13	65.0	6	30.0	19	95.0	1	5.0	20
Linseed Oil Works	14	56.0	10	40.0	24	96.0	1	4.0	25
Machine Shops	273	66.7	114	27.9	387	94.6	22	5.4	409
Match Factories	45	72.6	13	21.0	58	93.6	4	6.4	62
Mattress Factories	272	72.3	98	26.1	370	98.4	6	1.6	376
Mercantile	625	78.9	150	18.9	775	97.8	18	2.2	793
Metal Reduction Works	3	75.0	1	25.0	4	100.0	..	..	4
Metal Workers	592	64.9	280	30.7	872	95.6	40	4.4	912
Miscellaneous	381	69.2	145	26.1	526	95.3	26	4.7	552
Morocco Leather Shops	19	54.2	11	31.5	30	85.7	5	14.3	35
Motion Pictures	35	76.1	10	21.8	45	97.9	1	2.1	46
Munition Factories	16	36.4	19	43.1	35	79.5	9	20.5	44
Musical Instrument Factories	97	68.3	40	28.2	137	96.5	5	3.5	142
Oil Clothing Factories	10	71.4	4	28.6	14	100.0	..	..	14
Oilcloth and Linoleum Works	26	27.5	50	52.5	76	80.0	19	20.0	95
Oil Refineries	6	40.0	8	53.4	14	93.4	1	6.6	15
Packing House and Slaughter	82	65.0	39	31.0	121	96.0	5	4.0	126
Paint and Color Works	129	69.1	52	27.7	181	96.8	6	3.2	187
Paper Box and Papeterie	117	76.0	35	22.7	152	98.7	2	1.3	154
Paper Mills	296	51.0	232	40.0	528	91.0	52	9.0	580
Patent Leather Works	7	36.9	10	52.6	17	89.5	2	10.5	19
Picture Frame Factories	32	62.7	14	27.5	46	90.2	5	9.8	51
Plumbers' Supplies	14	82.4	3	17.6	17	100.0	..	..	17
Potteries	38	64.4	18	30.5	56	94.9	3	5.1	59

Table No. 9 — Concluded.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Printing and Lithographing	429	80.6	88	16.6	517	97.2	15	2.8	532
Pulp, Miscellaneous	7	26.9	14	53.9	21	80.8	5	19.2	26
Pulp, Soda	1	20.0	1	20.0	2	40.0	3	60.0	5
Pulp, Sulphite	18	38.3	21	44.6	39	82.9	8	17.1	47
Restaurants	21	77.8	5	18.5	26	96.3	1	3.7	27
Rice Mills	..	....	1	100.0	1	100.0	..	..	1
Rolling, Wire and Tube Works	20	52.6	16	42.1	36	94.7	2	5.3	38
Roofing Works	15	37.5	24	60.0	39	97.5	1	2.5	40
Rubber Cloth Factories	20	60.6	13	39.4	33	100.0	..	..	33
Rubber Reclaiming Works	3	27.3	7	63.6	10	90.9	1	9.1	11
Rubber Works	107	51.2	92	44.0	199	95.2	10	4.8	209
Saw and Planing Mills	73	44.3	56	33.9	129	78.2	36	21.8	165
Shirt Factories	37	84.1	7	15.9	44	100.0	..	..	44
Shoddy Mills	176	66.2	74	27.8	250	94.0	16	6.0	266
Silk Mills	44	68.7	16	25.0	60	93.7	4	6.3	64
Skin Mills	2	66.7	1	33.3	3	100.0	..	..	3
Soap Manufacturing	27	77.1	7	20.0	34	97.1	1	2.9	35
Stamping and Sheet Metal Works	42	60.9	21	30.4	63	91.3	6	8.7	69
Starch and Glucose Mills	11	50.0	4	18.2	15	68.2	7	31.8	22
Sticky Fly Paper Factories	3	75.0	1	25.0	4	100.0	..	..	4
Sugar Refineries	16	61.5	9	34.6	25	96.1	1	3.9	26
Tanneries	35	49.3	29	40.8	64	90.1	7	9.9	71
Tenant Manufacturing	472	71.7	153	23.3	625	95.0	33	5.0	658
Theatres	38	77.6	10	20.4	48	98.0	1	2.0	49
Tobacco Factories	43	67.2	18	28.1	61	95.3	3	4.7	64
Trunk Factories	9	69.2	4	30.8	13	100.0	..	..	13
Varnish Works	8	53.4	5	33.3	13	86.7	2	13.3	15
Wall Paper Factories	11	68.8	2	12.5	13	81.3	3	18.7	16
Warehouses	246	70.3	84	24.0	330	94.3	20	5.7	350
Waste and Batting Mills	212	62.2	116	34.0	328	96.2	13	3.8	341
Waste Paper and Rag Shops	45	60.8	26	35.2	71	96.0	3	4.0	74
Weaving Mills	97	64.7	49	32.7	146	97.4	4	2.6	150
Whip Factories	4	66.7	2	33.3	6	100.0	..	..	6
Window Shade Factories	9	81.8	..	....	9	81.8	2	18.2	11
Woodworkers, Class A*	110	51.4	77	36.0	187	87.4	27	12.6	214
Woodworkers, Class B*	122	51.1	93	38.9	215	90.0	24	10.0	239
Woodworkers, Class C*	109	60.5	61	33.9	170	94.4	10	5.6	180
Woodworkers, Class D*	75	59.1	36	28.3	111	87.4	16	12.6	127
Woodworkers, Class E*	109	65.3	48	28.8	157	94.1	10	5.9	167
Woodworkers, Class F*	28	60.9	14	30.4	42	91.3	4	8.7	46
Woolen Mills	843	70.8	294	24.6	1137	95.4	54	4.6	1191
Wool Storehouses	26	70.3	9	24.3	35	94.6	2	5.4	37
Worsted Mills	48	52.7	31	34.1	79	86.8	12	13.2	91
Total Sprinkler Fires	15,291		7,105		22,396		1,017		23,413

*The Woodworkers are classed as follows:

Class A. Interior woodwork, builders' supplies (including veneer works).

Class B. Box Factories (including cigar boxes).

Class C. Miscellaneous Woodworkers. Steam power tenant woodworkers (also woodworkers where there is a lack of detailed information as to class).

Class D. Sash, Door and Blind Factories.

Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).

Class F. Pails and Woodenware. (Plates, wooden bowls, tubs, etc.).

Table No. 10

Classification of Unsatisfactory Sprinkler Fires by Occupancy.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Agricultural Implements	3	..	..	..	..	..	..	..	1	..	..	..	..	4
Automobile and Bicycle	2	1	..	..	..	..	..	2	..	..	1	..	..	6
Bakeries	..	1	..	..	..	..	..	..	..	..	..	1	..	2
Boot and Shoe Shops	8	3	2	..	..	1	..	1	..	2	5	..	1	23
Broom Factories	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Button Factories	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Candy Factories	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Canning Works	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Car Houses	1	2	1	..	1	..	..	1	..	..	..	..	..	6
Car Works	1	1	..	..	..	..	..	1	..	..	..	..	..	3
Carpet Mills	4	1	3	..	..	..	..	1	..	..	..	..	..	9
Carriage Factories	1	2	2	..	1	..	..	1	..	..	2	..	..	9
Celluloid (Pyroxylin)	..	..	3	1	1	..	1	..	7	5	2	..	..	20
Cement and Plaster Works	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Cereal Mills	..	2	1	..	..	..	..	..	..	2	..	..	..	5
Chemical and White Lead	1	4	..	..	..	..	..	..	1	3	..	..	..	9
Clothing Factories	3	..	1	1	..	..	2	1	..	..	..	..	..	8
Coffee and Spice Mills	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Coffin Factories	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Cooperage Plants	1	3	..	..	..	1	..	3	..	..	1	..	..	9
Cordage Works	2	4	1	1	..	..	..	2	..	..	..	..	1	11
Cork Factories	1	..	..	..	..	..	..	..	..	1	..	..	..	2
Corset Factories	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Cotton Mills	22	16	6	2	..	1	5	1	2	..	..	4	4	63
Cotton Warehouses	12	1	2	..	..	..	1	4	1	..	..	1	..	22
Cotton Seed Oil Mills	2	4	2	..	..	..	..	..	..	..	..	2	1	11
Cutlery and Hardware	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Department Stores	4	3	..	..	..	..	..	1	..	..	2	..	1	11
Drug Houses	..	..	..	..	..	..	..	..	..	..	3	1	..	4
Dyeing, Bleaching and Finishing	4	2	1	..	..	1	..	1	..	..	1	..	1	11
Electrical Appliances	2	..	2	..	..	..	..	..	..	..	..	..	1	5
Electric Light and Power Plants	..	1	..	..	..	..	..	1	..	..	..	..	..	2
Elevators, Grain	..	3	4	..	1	..	2	1	1	1	2	..	1	16
Excelsior Factories	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Fertilizer Plants	2	..	..	..	1	..	..	..	..	..	..	..	..	3
Flour and Grist Mills	..	2	1	..	..	..	1	..	..	2	2	..	..	8
Foundries	6	1	1	..	..	..	..	..	..	1	..	..	..	9
Furniture Factories	16	13	2	3	..	..	2	9	6	..	3	..	..	54
Garages	2	..	..	..	..	..	..	2	..	..	..	..	..	4
Garbage Reduction Plants	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glass Works	1	1	1	..	..	..	..	1	..	..	..	1	2	7
Glue Factories	1	..	..	..	..	..	..	..	1	..	..	..	..	2

Table No. 10 — Continued.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Groceries	3	..	..	..	1	..	..	..	..	..	..	..	..	4
Hat, Fur	1	2	1	..	1	..	..	..	..	..	..	..	..	5
Hatters' Fur Mfg	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Jewelry Shops	2	1	..	1	..	..	..	..	..	..	..	..	..	4
Junk Shops	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Knitting, Cop Yarn	..	1	3	..	..	..	..	1	..	1	..	..	..	6
Knitting, Full Process	6	9	5	1	1	..	..	..	..	1	..	..	..	23
Laundries	1	..	..	..	..	..	..	1	..	..	..	..	..	2
Lead Pencil Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Linseed Oil Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Machine Shops	13	3	1	1	..	1	..	1	..	1	..	1	..	22
Match Factories	2	..	..	..	..	..	..	..	1	..	..	1	..	4
Mattress Factories	3	1	..	1	..	..	..	1	..	..	..	..	..	6
Mercantile	7	2	..	2	..	..	2	..	..	..	4	..	1	18
Metal Workers	13	13	2	..	..	..	2	..	3	2	2	1	2	40
Miscellaneous	6	4	2	1	1	..	3	..	3	3	2	1	..	26
Morocco Leather Shops	2	2	..	..	..	..	1	..	..	..	..	..	..	5
Motion Pictures	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Munitions Factories	2	..	..	1	..	..	..	..	4	1	..	1	..	9
Musical Instrument Factories	..	3	..	..	..	..	1	..	..	..	1	..	..	5
Oilcloth and Linoleum Works	..	4	..	..	..	..	1	3	11	..	..	..	..	19
Oil Refinery	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Packing House and Slaughter	1	2	1	..	1	..	..	..	..	..	..	..	..	5
Paint and Color Works	1	2	1	..	..	..	2	..	..	..	..	..	..	6
Paper Box and Papeterie	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Paper Mills	10	17	4	3	..	2	2	..	2	1	2	5	4	52
Patent Leather Works	1	..	..	..	..	..	1	..	..	..	..	..	..	2
Picture Frame Factories	1	2	..	1	..	..	..	1	..	..	..	..	..	5
Potteries	1	..	..	1	..	..	..	..	..	1	..	..	..	3
Printing and Lithographing	5	4	1	..	..	..	..	1	..	..	3	1	..	15
Pulp, Miscellaneous	1	1	2	..	..	..	..	..	..	1	..	..	..	5
Pulp, Soda	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Pulp, Sulphite	3	1	1	..	1	1	..	..	..	..	..	..	1	8
Restaurants	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Rolling, Wire and Tube Works	..	..	..	..	..	..	1	..	..	..	..	..	1	2
Roofing Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Rubber Reclaiming Works	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Rubber Works	5	..	..	1	..	..	..	..	3	1	..	..	..	10
Saw and Planing Mills	8	7	1	..	3	1	6	2	1	..	4	1	2	36
Shoddy Mills	5	2	5	..	..	3	..	..	..	..	..	1	..	16
Silk Mills	2	1	..	..	..	..	..	..	..	1	..	..	..	4
Soap Manufacturing	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Stamping and Sheet Metal Works	1	2	1	..	1	..	..	..	..	..	1	..	..	6
Starch and Glucose Mills	..	..	..	..	..	..	..	..	1	6	..	..	..	7

Table No. 10 — Concluded.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Sugar Refineries	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Tanneries	1	1	..	3	..	..	..	..	..	..	1	..	1	7
Tenant Manufacturing	14	5	2	2	1	..	1	1	..	..	6	..	1	33
Theatres	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Tobacco Factories	1	1	..	..	..	..	..	..	..	..	1	..	..	3
Varnish Works	..	..	1	..	..	..	..	..	1	..	..	..	..	2
Wall Paper Factories	..	..	1	..	..	..	..	1	..	..	1	..	..	3
Warehouses	9	3	1	..	2	..	..	3	..	..	..	..	2	20
Waste and Batting Mills	2	4	2	1	..	1	..	1	1	..	..	1	..	13
Waste Paper and Rag Shops	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Weaving Mills	1	1	1	1	..	..	..	..	..	..	..	..	..	4
Window Shade Factories	..	..	..	1	..	..	..	..	1	..	..	..	..	2
Woodworkers, Class A*	5	8	..	..	..	1	..	5	..	2	3	3	..	27
Woodworkers, Class B*	5	8	2	1	..	1	1	1	..	2	2	1	..	24
Woodworkers, Class C*	3	4	1	..	..	..	..	2	..	..	..	..	..	10
Woodworkers, Class D*	1	6	..	1	..	..	..	..	..	1	4	3	..	16
Woodworkers, Class E*	3	2	..	..	2	1	2	..	..	..	..	..	..	10
Woodworkers, Class F*	2	..	1	..	..	..	..	1	..	..	..	..	..	4
Woolen Mills	11	15	10	1	..	2	3	..	1	..	3	4	4	54
Wool Storehouses	..	2	..	..	..	..	..	..	..	..	..	..	..	2
Worsted Mills	2	3	2	1	..	..	..	..	..	..	..	2	2	12
Total Unsatisfactory Fires	283	224	93	36	21	18	46	60	53	46	66	37	34	1017

*See detailed classification of woodworkers as given in note under Table No. 9.

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